

# FUNCTIONAL BRACING OF COLLES' FRACTURE

THESIS  
FOR  
( MASTER OF SURGERY )  
( ORTHOPAEDICS )



BUNDELKHAND UNIVERSITY  
JHANSI (U. P.)

2002

---

1993

UTTAM KUMAR VAISH

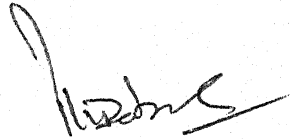
---

CERTIFICATE

This is to certify that the work entitled, "FUNCTIONAL BRACING IN COLLES' FRACTURE", which is being submitted as a thesis for M.S. (orthopaedics) examination, 1993, of Bundelkhand University, by UTTAM KUMAR VAISH, has been carried out under my direct supervision and guidance. The techniques embodied in the thesis were undertaken by the candidate himself and observations recorded have been checked by me.

He has put in the necessary stay in the Deptt. of orthopaedics, according to university regulations.

Dated: Oct 1992

  
(P.K. DABRAL)  
M.S. (ORTH.)  
Professor & Head,  
Department of Orthopaedics,  
M.L.B. Medical College,  
Jhansi (U.P.).  
(GUIDE).

## ACKNOWLEDGEMENT

Co-operation, Help, Guidance, Encouragement, Supervision and Criticism are the essential ingredients of the battery which is necessary for keeping a study going. After the study is completed it is ones pleasure to be able to extend ones gratitude towards the non exhausting sources of these essential ingredients. This study can not stand the brunt of being an exception to this statement. I feel elated on having the opportunity of expressing thanks from the depth of my heart to all the members of the faculty of orthopaedics for the enourmous help and encouragement they provided me while the study was on. It is invidious to name only a few, but my personal thanks must go to my esteemed and learned teacher, Professor P.K.Dabral, M.S., Head, Deptt. of Orthopaedics for his able guidance, constructive and valuable suggestions, thoughtful criticism and meticulous attention which accompanied this work till its completion. For him my reverence has always been at its zenith. I find myself robbed of words to express my feeling of indebtedness for him.

I deeply express my gratitude to my esteemed and dignified teacher Dr. R.P.Tripathi M.S., M.A.G.S., Associate professor in the Deptt. of orthopaedics whose exemplary dedication, fathomless knowledge and experience shall remain a constant source of inspiration throughout my life. I express my gratitude towards him.

I express my deep sense of gratitude towards Dr. D.K.Gupta, M.S., Assistant professor in orthopaedics who inspite of not being able to join his hospital duties proved

to be a constant source of ideas and suggestions.

I fail to find words to express my gratitude towards Dr. Anurag M.S., Assistant Professor of orthopaedics, whose keen observation was always there to find out whatever was wrong and thus the shortcomings of the study were corrected. He has always been kind enough to help me at the cost of his personal inconvenience.

I fail in my duty if I do not appreciate the indispensable help provided by all of my departmental colleagues in completing this study.

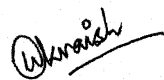
I have no words to express my gratitude towards my parents who have always been a source of inspiration without which this work would not have been completed.

The contribution of my wife to this work cannot be ignored as she was always there, cooperating and providing all the required help. I express my profound gratitude to her.

I am deeply indebted to all those patients who submitted themselves to this study. Without them this study could not have been done.

I am thankful to Mr.K.Venugopal Rao too who meticulously made a neat typescript of this work so that it could be presented in its present form.

Dated: 12<sup>th</sup> Oct 1992

  
(UTTAM KUMAR VAISH)



## CONTENTS

CHAPTER	PAGE No.
1. INTRODUCTION	1 - 6
2. REVIEW OF LITERATURE	7 - 32
3. MATERIAL AND METHODS	33 - 42
4. OBSERVATION	43 - 63
5. DISCUSSION	64 - 70
6. CONCLUSION	71 - 72
7. BIBLIOGRAPHY	73 - 79
8. SUMMARY ( In a separate cover)	1 - 4

# ***INTRODUCTION***

## INTRODUCTION

The evolution of Human brain has given rise to all the mechanization which one discovers all around him. The industrial mechanization, the agricultural mechanization, the mechanization in the household, on the rails and roads, & in every walk of life is all a boon to the mankind. In combination with carelessness or minds full of competitive stresses which are commonly encountered these days, this boon appears to be a curse when accidents result. Fractures of the lower end of the radius being one of the commonest ones to occur in the elderly individuals especially the female ones.

## ANATOMY

The distal end of the radius is responsible for the bony articulation between forearm and hand. The rectangular distal part is mostly cancellous, surrounded only by a thin cortex. The posterior aspect is convex and is covered by the grooves for the extensor tendons. The anterior surface is concave and is in relation directly with the pronator quadratus muscle over which pass the flexor tendons, and the median nerve. The tip of the radial styloid which gives insertion to the radial collateral ligament, projects approximately one-half inch further distally than that of the ulnar styloid.

The medial surface of the distal end of the radius contains the ulnar notch for the articulation with the ulna. The carpal articular surface is inclined downward at an angle of 10-15 degrees, while the inward, ulnar tilt has an average of 25 degrees. The stability of the distal radio-ulnar joint

is maintained by a triangular fibro cartilage, extending from the distal margin of the ulnar notch to the base of the ulnar styloid. The lower end of radius is much wider than the upper end; the bone here is cancellous and is subject to marked osteoporosis with advancing age.

A fracture of the lower end of the radius is one of the commonest orthopedic injuries. This goes by the name of Abraham Colles. Claude Pouteau described this fracture for the first time in a memoir published in 1783 but little attention was paid to Pouteau's work. Later in 1814 Abraham Colles described this fracture in his paper titled "On the fracture of the Carpal extremity of radius".

Abraham Colles was born in Ireland and did his postgraduate medical studies at Edinburgh and obtained his M.D. degree in 1797. At 29 he was elected president of the Royal college of surgeons of Ireland. According to him this fracture occurs at about an inch and a half above the carpal extremity of radius. This was much before the advent of radiography. According to present radiological criteria Colles' fracture is a transverse fracture of distal end of radius less than 2.5 cms from the wrist with an often broken off ulnar styloid process, with the radial fragment shifted and tilted backwards, shifted and tilted radially, impacted and supinated. These all produce the classical "Silver fork or the dinner fork deformity" of the wrist and hand.

With the advancement of the health care services and their easier availability the average life expectancy of

human beings has increased, thereby making available more elderly individuals who are the usual victims of this injury.

Rarely this fracture is also known as POUTEAU'S fracture. Never the less of all the eponymous fractures probably none is so well associated with a person's name as is that of the distal radius with Abraham Colles.

In the past various surgeons have attempted to maintain the reduction achieved in a dorsal splint (BOHLER 1929), circular plaster cast extending above elbow (White, McNutt and Clock et al). The prolonged extended immobilization with above elbow plaster of Paris cast has been proved to be not of advantage over a below elbow plaster. The importance of a normally functioning hand and wrist needs no emphasis, whether in earning a living, practicing a hobby or performing daily pursuits of life. The value of a strong co-ordinated hand in such activities as writing, painting, and manipulating tools is obvious. Less obvious is the extent to which the hand is reflection of personality and a vital organ of expression. One has to consider the manual signs and attitudes of an oriental dancer, benediction of a priest, or the gestures of a conductor to realise how much more is the hand than a prehensile and sensory tool; and this all is attributable to the flexibility of finger and wrist joints.

Patients, particularly older ones who are the usual sufferers of the Colles' fracture suffer difficult stiffness of the wrist, the metacarpophalangeal joints, the interphalangeal joints and the shoulder joints in a

conventional below elbow plaster cast used for the treatment of Colles' fracture. Many enthusiastic surgeons have attempted open reduction and internal fixation of the Colles' fractures. But the anatomical reduction which can be achieved with the help of surgical intervention and which can be maintained with the help of internal fixation, remains of no use if following the surgery the mobilization cannot be carried out. The impediment to early mobilization in such cases is the post operative pain and the inflammation caused by the surgery. The additional risk of infection in cases of Colles' fracture treated by surgery makes the surgical treatment noncompatible to good functional results. So it is much better to have a malunited or an ununited fracture with a good functioning hand than to have an excellently united and aligned fracture with a stiffened painful set of non functioning fingers. BARTON particularly advocated the principle of early motion to prevent adhesions and joint stiffness. It has been shown that early mobilization leads to significantly less pain in both the short and long term. After early mobilization of an injury, the blood supply to bone and soft tissues returns rapidly to normal and joint stiffness is decreased (MILLER et al. 1979, SALTER et al 1980).

In recent years SARMIENTO et al, GUPTA et al, BUNGER et al, ROSS et al, FERRIS et al etc. have all popularised the concept of functional bracing in the management of Colles' fractures. The brace provides support to the fracture,

maintains the reduction of the fracture fragments and besides this the ability to mobilize the muscles improves circulation to the injured part by massaging effect of the muscles on the incorporated vessels. Movements of the fingers also result into mobilization of oedema fluid from the injured part which otherwise would be allowed to collect inside the joint capsules and ligaments of the joints resulting in temporary or permanent loss of function. The functional brace thus offers the physiological solution to many of the problems related to long continuous immobilization either in traction or in plaster. The plaster casts have lost their significance over the functional polyethylene braces as the plaster casts have to be changed quite often as the swelling vanishes or the fracture fragments lose their position in a loose plaster. The polyethylene braces can be tightened with the help of fasteners attached to them as the swelling subsides. With brace treatment the focus of attention is also upon the reduction of the period after injury for which the person is kept away from his work. The recent interest in the functional bracing is undoubtedly a reflection of economics of medical care. In the present study the patients were encouraged to use their fingers, wrist, elbow and shoulder after applying the polyethylene functional brace individually for each patient of Colles' fracture.

### AIMS OF THE PRESENT STUDY

1. To evaluate the suitability of below elbow functional bracing for early restoration of function of wrist and hand by way of their mobilization.
2. To evaluate the suitability of below elbow functional bracing for maintenance of the fractured fragments of radius after reduction.
3. To evaluate the effect of below elbow functional bracing on the union of colles' fracture.



# ***REVIEW OF LITERATURE***

## REVIEW OF LITERATURE

As the mankind is advancing towards the twentieth century the proneness to accidents is increasing as a result of mad rush of day to day life. The fractures have become inevitable with this increased speed of life.

Since time immemorial man has been beset by problems of accidents and injuries and has been trying to effectively cope with them. It will not be improper to say that the history of fractures and their treatment dates back to the advent of human race on this planet. Since no mode of recording the events existed in those times, there are no data on the method of treatment practiced during that period. Some glimpses of the knowledge that existed are however possible through the various scriptures that came into being subsequently.

The evidences from the ancient period prove that thousands of years ago, broken bones were fixed by spirit, in much the same way as it is being done today. The fractures after current diagnosis were treated by traction by means of pulley (CHAKRA) or by immobilization by bandh (bandages), bark splints or bamboo strips.

In our country earliest references to the subject of healing of bones are found in ATHARVAVEDA, some 2000 years B.C. later on Samhitās of Charak and Sushruta originally written about 1000 years B.C. deal with the diagnosis and treatment of various types of fractures and dislocations.

Sushruta Samhita contains in it essence of all that was known with the regard to surgery and fundamental sciences

closely related to this art. The orthopedic treatment which was based upon rich experience of surgery was rationale and at times ingenious. Sushruta has described six types of dislocations and twelve types of fractures, while dealing with diagnostic considerations (NIDAN STHANA SECOND, CENOTO OF SUSHRUTA SAMHITA QUOTED BY SINGHAL, 1977).

Hippocrates in the third century B.C. said that bandaging should be done quickly, without pain, with ease and with elegance.

From the time of Hippocrates to the beginning of the nineteenth century, fracture of the distal end of the radius was mistaken for dislocation of the wrist. The possibility of their occurrence was first mentioned by PETIT. Prior to this these fractures were considered to be luxation subluxations of the wrist or separation of the distal radio ulnar joint. This error was corrected by CLAUDE POUTEAU (1725-1775). In a memoir published posthumously in 1783 he described the fracture of the distal end of the radius with posterior tripping or displacement of the distal fragment. He recognised that there were several types of fractures of the distal radius, some of which were impacted and did not exhibit crepitus. DESAULT was reluctant to accept Pouteau's opinion and like Petit described both fractures of the radius and dislocations of the radioulnar joint.

Little attention was paid to Pouteau's work outside France, so Colles was unaware of it when he published his paper "On the fracture of carpal extremity of the radius" in 1814. He described this fracture taking place about an inch

and a half above the carpal extremity of the radius and exhibiting the following appearances:" The posterior surface of the limb presents a considerable deformity; for a depression is seen in the forearm, about an inch and a half above the end of this bone, while a considerable swelling occupies the wrist and metacarpus. Indeed the carpus and base of metacarpus appears to be thrown backwards so much as on the first view to excite a suspicion that carpus had been dislocated forward." Fracture of distal end of the radius is confined to adults and is usually seen in women more than 50 years of age, who have fallen on outstretched hand. The findings include one or more of the following: Dorsal angulation, dorsal displacement radial angulation Radial displacement, supination, impaction, comminution, fracture of styloid process of ulna with disruption of inferior radio ulnar joint.

ABRAHAM COLLES (1773 - 1843) (Fallon & Peltier) was the greatest of Irish surgeons and a distinguished professor of surgery of the Royal college of surgeons of Ireland. He excelled as clinician, teacher and anatomist. His eponym is attached to fascia, a space, a law and a fracture. His description of the fracture of distal end of radius is a classic of brevity and clarity. It is not accompanied by an illustration and surprisingly, there was no report of the dissection of such an injury. Perhaps this accounts for the fact that Colles placed the fracture so far proximally (Peltier).

Colles' description of a fracture of a distal end of

radius was published in a provincial medical journal and like Pouteau's received little attention (Peltier). It was GUILLAUME DUPUYTREN (1777 - 1835) who brought these fractures to the attention of a host of students and through his published lectures to the surgical world at large (Peltier 1958). He separated the displacements of the distal radial epiphysis and fractures of the distal end of radius from radio carpal dislocation.

Goyrand (1832) found that in most fractures of the distal end of the radius the distal fragment was displaced dorsally.

Alfred Armand Velpeau (1795 - 1866) termed the usual deformity seen in the fractures of distal end of the radius "Talon de fourchette" which, translated to English meant the "silver fork deformity". (Malgaigne).

The surgeon who performed the postmortem examination of the body of the Abraham Colles firmly attached the eponym of Colles to the common fracture of distal radius. (Peltier).

In 1838 Barton described anterior and posterior fractured dislocation of the wrist. This was much before the advent of the X rays. In fact the Barton's posterior fracture dislocation was probably a Colles' fracture. (James Ellis 1965) After Abraham Colles so many orthopaedic surgeons have contributed quite a lot regarding patho mechanics, treatment and healing of this fracture.

At a meeting of the physicians of the German poliklinik in New York in October 1897 Carl Beck reported on the X ray findings of 44 patients with Colles' fractures. he had been

using the X rays less than 3 months after Rontgen's first announcement on December the 28th 1895. his reaction was similar to that of most of his contemporaries when they first began to use X rays for diagnosing Colles' fractures. He was surprised that the diagnosis made before a skiagram was taken, was not more or less modified thereafter, especially when considerable effusion and swelling were present.

#### OCCURENCE OF COLLES' FRACTURE

Day to day observation and reports of large services have shown that this fracture is limited to middle and advanced life. BACORN and KURTZKE(1953) in a study of 20000 cases from the New York state workmen's compensation board, found a mean age of 48.2 years for this fracture.

Casting and his group in a series of 524 cases, report a mean age of 49 years. The fracture is more common in females than in males.

Alfram (1962) in a valuable study of the fracture in the population of Malmo (209, 473), the third largest city in Sweden, has found that before the age of 40, the incidence of fracture in the distal end of the forearm is about equal in males and females. Above the age of 60 years the incidence was 7 to 1 in favour of females. Furthermore he pointed out that this rise of incidence was associated with progressively less severe trauma and marked displacement of the fracture. As he concluded, progressive fragility of the skeleton seems to be a major cause of fracture at this level in women.

Depalma in a study of thirty nine patients reported the range of age from thirty six to sixty nine years with

eighteen females and ten males. In their study right wrists were involved in seventeen cases and left in eleven.

Dowling et al in a study of comminuted Colles' fractures reported a prominence of females in their study and 55.7 years as the average age of the patients.

In a long term follow up of Colles' fracture Smaill reported an average age at the time of fracture to be fifty six years with women dominating the list. The left wrist was affected in 53% of cases and the right wrist in 47% in this study.

Green (1975) reported an average age of 50.6 years in a study of seventy eight fractures. There was a mean age of 63 years and there were fifty three women and seven men in a study of unstable Colles' fracture conducted by Cooney in 1979. The patients' age averaged 57 years with a predominance of females (Clancey 1984). The average age was in the fifth decade as reported by Sandhu (1986).

#### **PATHO MECHANISM**

For many years there was a good deal of discussion concerning its mechanism. It may be said that there are three main theories in the literature concerning the mechanism of injury in the fractures of distal radius (FRYKMAN 1967).

- (a) A blow and counter blow theory This theory, first advanced by Dupuytren (1834), suggests that body's weight generates counter blow from the surface of impact and is thereby transmitted through the carpal bones directly to the distal radius. The fracture

produced is often typically located where the cortex of the bone is thinnest. Nelaton (1844) and Malgaigne (1847) subsequently adopted this theory, as did Destot & Gallois (1896). The later demonstrated roentgenographically that, when the hand is in dorsiflexion, the carpal bones come up against the surface of impact at the moment of fracture at the same time as the head of the radius is pressed against the humerus, thus causing the force to be transmitted directly to the lower part of the radius.

b) The avulsion Theory

First suggested by Linhart (1852), this theory was analysed more closely by Lecomte (1861), who pointed out that the design of the Olecranon gives the Ulna much more intimate contact than the radius with the humerus and that consequently, the ulna is probably alone in absorbing the impact of a fall on the hand. The force must be transmitted in some way to the radius. According to Laconte, this must occur via the interosseous membrane and, more importantly the ligaments particularly the strong volar apparatus. The resultant fracture is then produced by avulsion due to traction in the strong volar radio-carpal ligament.

c) The bending fracture theory:

This mechanism was suggested by Meyer (1925), who definitely rejected the avulsion theory. he argued that the course of the fracture in the individual case is



determined by three factors: the position of the hand, the surface of impact and the magnitude of the force. If tension simultaneously arose in the ulnar collateral ligament, the radial fracture would for instance always be accompanied by a fracture in the ulnar styloid process. The bending fracture theory was later supported by Robin Lewis (1950). He states that when the outstretched hand strikes the ground, it stops, while the rest of the limb keeps moving. The forearm is rotated over the hand by extension of the wrist, then the fracture occurs, with compression applied upon the posterior thin cortex. Posterior displacement, volar angulation and radial deviation are present. The recurrence of this threefold deformity after treatment, is the basis of the so called settling of the distal fragment. Avulsion of the ulnar styloid, distal radio-ulnar derangement, and extension of the fracture line into the radio-carpal joint can occur as well. Robin Lewis' theory seems to be favoured by most authors (PARISIEN 1973)

#### METHOD OF TREATMENT OF COLLES' FRACTURE

##### CORRECTION OF FRACTURE

The following is a review of literature of the various methods used to obtain good correction of fracture. FORD AND KEY (1955) drew attention to the diversity of treatment when they stated : "There are as many methods of reduction as there are fracture surgeons."

Colles in his original paper (1814) recommended

reduction by means of traction, in the mid position between pronation and supination and as a pivot, he used a firm compress bandaged over the flexor surface of radius at the site of fracture.

The reduction technique suggested by BOHLER in (1923) still seems to be most widely used. (Lidstorm, 1959; Hamsa, 1962; Guttman, 1964; Older, Stabler and Cassebaun, 1965; Sorea 1965) though some authors still refer to the technique described by Robert Jones (1915), which was dorsiflexion followed by reduction and immobilisation.

Two methods of reduction of this fracture are known:-

- (A) The first prevailing method of Pilcher-Malgaigne has two components. The wrist is first strongly hyperextended with traction and counter traction until the impaction is found, then the distal fragment is pressed in a volar direction, while the wrist is manipulated into flexion and ulnar deviation.

Without distraction and increased backward angulation the serrated surfaces of the fracture can not be matched correctly, appears to be justified by mechanically analogous Charnley's technique.

ched correctly, appears to be justified by mechanically analogous Charnley's technique.

This method may add to the injury of the soft tissues anterior to the wrist (Watson Jones). The impaction present over the posterior aspect will be increased by the way of hyperextension (Carothers)

(B) The other method of reduction of Colles' fracture, method by traction, is done by exerting a strong and steady pull of the fingers, while countertraction is performed at the elbow. Watson-Jones' modification consists of completing the reduction by direct pressure. This reduction by traction has been taught for many years by BOHLER. Instead of manual traction some prefer instrumental traction (John Cardwell 1931, John Bate 1969).

Carothers described a method by which traction, on the thumb only is applied. He felt that in this way the hand could be thrown into more ulnar deviation.

#### POSITION OF IMMOBILIZATION

As soon as the reduction is accomplished immobilization of the fracture is done. The position of immobilization is controversial. Bohler, Merle D'Aubigne, and Watson-Jones advise a mid position between volar and dorsal flexion with ulnar deviation. Slight flexion with ulnar deviation has been advocated by authors like Cassebaun, Cozen, Darrach, Gartland, Platt, Charnley and others.

The shade position which consists of forced flexion which prevents active finger motion has no advocate at the present time.

Forced flexion, followed by neutral position of wrist, has been tried by Gartland, Werley, the Judet Brothers and many others.

Slight flexion then additional flexion after wedging the cast, as a method of immobilization to prevent displacement has been reported by LEWIS COZEN.

Immobilization in forced pronation, the so called "Cotton-Loder position" based on the idea that the lower end of the radius has a tendency to slip into more supination, has been used by Cotton, Carothers, Lowell, Mayer and De Palma.

#### IMMOBILIZATION

Colles (1814) in his original paper mentioned about the malleable tin splints which he used to apply to both surfaces of forearm along with a wooden splint which was recommended "along the naked side of ulna, to hold the two bones in contact. The cases is treated on this plan" he says, " have all recovered without the smallest defect or deformity of the limb in the ordinary time for the cure of fractures."

In the first quarter of the present century the treatment had altered little from the above description. Immobilization was by a wooden Carr's splint and massage was begun soon after the injury. The result of these methods are not easily assessed.

Much before Colles in 1769 Percival Pott emphasised the use of splints which included one joint above and one joint<sup>r</sup> below the fracture.

Initially wheat glues and later wax and resins were used to form bandages that set hard to provide splintage to the injured parts. Rhazes, an Arabian physician wrote : " But if thou make thi~~y~~ne apparatus with lime and white of egg, it will be much handsomer and will not be removed until the healing is complete".

In the 18th century, Cheselden in England was a keen

advocate of egg-white bandages for splinting the fractures. But in Arabia plaster was used. Mr. Eton the British counsel in Bassora, wrote in 1798 about a method of setting bones by enclosing the broken limb in a plaster of Paris (Gypsum) case after the bones were put in their right place. He wrote that Plaster of paris case took exactly the form of the limb, without any pressure and in a few minutes the mass became solid and strong.

In Europe Hubenthal seems to have used plaster of paris in 1816; it was mixed with ground up blotting paper.

In America, Samuel St. John of New York was a strong advocate of plaster because, he taught that the splint must be fitted to the limb and not the limb to the splint. He introduced the padding of the plaster with cotton.

Sir George Billingham wrote in outline of Military surgery in 1852 about a method of enclosing of fractured limbs in moulds of clay akin to practice of enveloping of fractured limbs in splints and bandages.

Antonius Mathysen (in 1852) was the first to device the plaster of paris bandages by rubbing plaster of paris powder into coarse cotton material. He thus popularised the use plaster of paris bandages.

Robert Jones (1915) following reduction by his prescribed method advised immobilization of fractured limb in a below elbow plaster cast.

Bohler (1929) used only dorsal splint for the immobilization of Colles' fracture after reduction.

Lambirinudi (1938) pointed out that a Colles' fracture

was the result of a supination injury and should therefore be held in pronation in an above elbow plaster after reduction. First of all the circular plaster of paris casts extending above the elbow in fracture of the distal end of the radius were used by WHITE (1940), McNUTT (1956) and CLOCK et al (1957).

In traditional chinese medicine the treatment of Colles' fracture is by bamboo splints similar to those originally described by Colles. (CHOW et al. 1964)

Kudelka (1963) recommended after reduction of Colles' fracture, a lightly padded plaster cast, with the elbow at right angle and forearm fully pronated, extending from the middle of the shaft of the humerus to the level of metacarpal heads; and allowing full flexion of metacarpophalangeal joints and not including the thumb. He recommended this plaster for six weeks and during which the patient regularly exercised the fingers and the shoulder.

Criticising the flexion position of wrist while immobilizing he said that this may lead to pressure sores over the distal fragments and recommended neutral position of the wrist during immobilization. He also criticised the below elbow plaster immobilization.

Analysing the flexion position of wrist during immobilization (Cotton 1919) Golden (1963) said that the position of full flexion at wrist combined with pronation and ulnar deviation was undoubtedly a very stable position and a below elbow cast then would suffice. But this position of flexion if maintained for long enough to secure early union,

may cause flexor contracture and permanent stretching of the extensor tendons. Between 20 degrees and 30 degrees of the flexion is a safe position to be maintained for four weeks. Strong ulnar deviation is essential, because it is the chief means of maintaining the radius in its proper relation to the ulna.

MOORE (1958), among others has advocated delay in the treatment of many fractures where there are no complications demanding immediate reduction. In uncomplicated Colles' fractures such delay is advantageous as pain can be controlled by a splint or plaster slab and a few tablets of aspirin according to him.

Golden (1963) in a study of Colles' fracture demonstrated a close communication between satisfactory reduction of deformity, its maintenance until union and good ultimate result.

Many authors have advocated use of circular plaster cast on the forearm instead of the conventional treatment. (GUTTMAN, SORE). Others have recommended sugar tong cast with a circular plaster bandage. (KANE, KENNEY, OLDER et al & MILLER).

Sarmiento (1965) proposed that the brachioradialis plays an important role as a deforming force in Colles' fractures. He proposes to treat Colles' fractures with very simply applied and anteroposteriorly flattened below-elbow casts, holding the forearm in supination and extending over the neck of the 2nd metacarpal while the wrist is maintained in ulnar deviation.

In a five year follow-up of forty one patients of Colles' fracture Smaill (1965) reported not so satisfactory objective results as subjective ones. To him Colles' belief that in time the patient would regain full painless function irrespective of how the fracture was treated seemed to be vindicated.

Unless the resulting deformity is unacceptable the impaction of Colles' fracture is often best left unreduced, both because redisplacement is so common and also because good function is compatible with malunion. (JAMES ELLIS 1965)

In Linden & Ericson's (1981) study of 250 consecutive cases of Colles' fracture, analysis of various radiographic criteria for displacement showed that only the measurement of dorsal displacement and radial displacement were independent of each other. These measurements suffice for comparison of series. The fractures were randomly divided into five equal groups, immobilized according to five different techniques. The technique of immobilization was found to be of subordinate importance for the final results, which are determined by the original displacement and the success of reduction.

Peltier (1984) publishing an historical account on the fracture of distal end of radius mentioned that whatever their fallibility eponyms illustrate the lineage of surgery and bring to it the colour of old times, distinguished figures, ancient signs and pertilences' and continually remind us of the international nature of science which was said by Mark Ravitch (1979). Peltier also discouraged the use



of eponyms.

Villar et al (1987) made a prospective study over a three years period of 90 consecutive Colles' fractures. The radiographic feature which was found most significant was shortening of the radius one week after the reduction of the fracture. Persistent dorsal tilt, radiocarpal joint involvement and ulnar styloid fracture were each associated with reduced range of movement but had no effect on grip strength. Radial tilt of the radial fragment did not correlate with any aspect of the result after three years.

Mc Auliffe (1987) presented the results of a prospective study of early mobilization of Colles' fractures and found that it produced less pain & stronger grip.

Gupta. A. (1991) published a prospective study on 204 consecutive patients with Colles' fracture who underwent closed reduction and plaster immobilization in the three different positions of wrist randomly allocated; which were Palmer flexion, neutral and Dorsiflexion. On comparing the results of three groups immobilization in dorsiflexion showed the lowest incidence of redisplacement, especially of dorsal tilt and had best functional results.

With the aim to eliminate the need for plaster immobilization in fracture treatment L.V.Rush et al. (1949) developed a pin for internal fixation of fractures of most long bones while leaving the extremity free for function. He extended this modullary pinning to the Colles' fractures and found that gross deformity did not occur in these cases.

Fixation was stable in 43 out of 89 cases. Full function was regained by approximately 84 per cent of patients within 4 weeks after surgery.

The failure to achieve satisfactory results and high figures of loss of position of fragments prompted renewed interest in the management of this lesion. A new method was evolved in which following manipulative reduction of the comminuted Colles' fractures most distal radial fragment was held by passing a threaded wire through the ulna into the distal most radial fragment. This limb was then immobilized in a below elbow plaster cast for eight weeks. This yielded a satisfactory percentage of excellent or good results. Although in a few cases low grade infection around the protruding wire and distraction in some of the cases occurred. (Depalma 1952).

Dowling (1961) published a similar method of treatment the only difference being the use of Stenmanns pin instead of a threaded Kirschner wire. He also reported similar results.

Stein & Stanley (1975) used a method using two K-wires to stabilize commuted fragments of the distal end of radius and reported encouraging results. Clancey (1984) made a similar study on committed Colles' fractures with a similar method and showed that additional fixation improves both the anatomical and functional result. This method was also advocated by SANDHU et al (1986).

SCHECK(1962) passed two K wires one through the bases of metacarpals and the other through upper ulna. Traction and

countertraction were applied through these wires by Roger-Andersons' reduction apparatus and wrist was immobilized in plaster cast in slight palmar flexion, ulnar deviation and pronation of forearm for four weeks and in short arm cast for 3-4 weeks. The anatomical results were satisfactory in 75 percent of the patients and unsatisfactory in 25 percent.

COLE & OBLETZ (1966) treating comminuted fractures of distal end of radius by skeletal transfixation in plaster cast reported 51 percent excellent and 43 percent good results using McBride system of disability evaluation. In this study he immobilized the comminuted fractures of lower end of radius for eight weeks. He encouraged his patients to use their fingers, elbow, and shoulder as soon after surgery as pain permitted. In a similar study conducted by GREEN (1975), 86 percent of the patients had good or excellent results. KAIN et al in 1977 reported a study with similar method of treatment by transfixation in plaster and produced 72 percent satisfactory results. The complications of this method of treatment; loss of radial length, pin track infection, loss of purchase of the pin in the bone were common to all the similar studies.

COONEY et al (1979) carried out a study on unstable Colles' fractures using a double pin Roger Anderson's apparatus with pins placed perpendicularly in 2nd and 3rd metacarpals and in the distal part of the radius. Objective analysis revealed 90 % good to excellent, 8 % fair and 2 % poor results. 92 % had no pain, 89 % had no deformity and the

mean grip strength was 20 kilograms. Several had pin loosening which occurred most frequently late during the course of treatment.

KRISTIANSEN (1968) has worked out a method to prevent or correct final deformity of the radius. The method is based upon the principle of restoring the anatomical conditions by bone grafting, combined with an internal fixation of the fragments by means of a K-splint which is hand shaped with three fingers on the dorsal side and one finger on the radial side holding the distal fragments in reduced position. He operated 26 patients with this method. Both anatomical and functional results were evaluated as excellent in seven cases, good in six cases, fair in four cases and poor in six cases.

Fractures of the distal radius have been routinely treated by closed techniques. (Charnley) Even displaced intraarticular fractures of the distal radius have until recently been accepted without anatomic reduction because of lack of reliable technique of fixation (ROCKWOOD 1975).

Over the past two decades further understanding of the sequelae of intraarticular incongruity has led to increased concern about the anatomic restoration of the articular surface of distal radius. (MELONE, MULLER & ROCKWOOD).

Open reduction and internal fixation can lead to excellent results if the reduction is anatomic and the fixation is adequate to allow early motion. (BASSETT 1987).

When one studies the published statistics one cannot avoid concluding that improvement is needed in the treatment

of fractures of the distal end of the radius. In all series many unsatisfactory results are published in cases of fractures of lower end of the radius. Recurrence of deformity following either closed reduction or pin fixation of unstable Colles' fracture is all too common.

SARMIENTO (1975) a pioneer in functional bracing of fractures after establishing early mobilisation as an acceptable alternative to the prolonged immobilization or internal fixation in the treatment of intraarticular fractures of shoulder, elbow, and knee extended this mode of treatment to the fractures of the lower end of radius. He treated 44 consecutive comminuted intraarticular fractures of the distal end of radius by initial immobilization of the arm in an above-the-elbow cast with the elbow in flexion, the forearm in supination, and the wrist in moderate ulnar and volar flexion. This cast was changed for an orthoplast brace after a few days. This brace permitted motion of the elbow, volar flexion of the wrist while preventing pronation and supination of the forearm and dorsiflexion of the wrist. This method did not prevent collapse of the fragments in all instances. However the degree of collapse was minimum. He obtained excellent or good results in 82 percent of the cases. In the brace the reduction of the fracture was maintained while allowing wrist motion. In his study the patients with significant amount of collapse even had good functional results, which they attributed to the supination and hinged wrist of the brace.

SARMIENTO (1980) in another study and ROSS et al (1984) showed that early mobilization of wrist joint after Colles' fracture leads to early recovery.

GUPTA et al. (1981) In a study of treatment of 21 comminuted colles' fractures by functional bracing in supination found that it shortens the period of rehabilitation and reduces the incidence of various complications while effectively maintaining the reduction of fractures.

In 1982 ROSETZSKY in a prospective randomized controlled trial polyurethane casts and traditional plaster of paris braces were compared in 46 cases of Colles' fracture of the forearm. In comparison with plaster the synthetic bandage is lighter, water repellent and hardens faster. No negative effects were observed concerning the patients' complaints or the need to secondary adjustments of the cast.

GIBSON AND BANNISTER (1983) In a randomized controlled trial reported that the patients treated in functional brace in supination were better at 9 weeks than those in supinated or pronated cast. They used thermoplastic sheet for the brace. They advocated the use of functional brace in supination. They also found that good functional result was frequently seen in the presence of poor anatomical reduction.

STEWART et al (1984) investigated 243 patients with displaced Colles' fractures in three groups: Group One with conventional Colles' plaster, Group Two with above elbow cast-brace with supinated forearm, Group Three with below elbow-cast brace. The anatomical result was found not influenced by

the method of immobilization but was related to the efficacy of reduction. Loss of position in braces was no greater than in plaster. Early hand function and supinated position advocated by Sarmiento were found to confer no anatomical or functional advantage.

RUBINOVICH AND RENNIE (1984) undertook a comparative retrospective study to establish or deny a correlation between functional and radiographic end results in Colles' fractures. 37 patients were followed up for a mean of 51 months. 76% of the patients had been rated excellent or good and 24% fair. Statistical analysis showed that strength was the clinical index which differentiated satisfactory from unsatisfactory results, while dorsal tilt was the only radiographic sign which significantly affected the final result.

ROSS et al (1984) compared the effects of functional orthoplast brace keeping the forearm in supination and below elbow plaster cast. This study showed that functional bracing rendered the wrist pain free, with less disability, less restriction of movement. These results would appear to be independent of anatomical result.

A randomized clinical trial of functional bracing in supination (FUSU) versus dorsal plaster immobilization (DPI) was conducted by BUNGER et al (1984) in 145 patients with Colles' fracture. A dynamic wrist unit was developed and used in FUSU group. The anatomical end result after FUSU was excellent or good in 80% of the patients versus 64% after

DPI. Functional recovery was equal after 7 weeks and 3 months. The functional benefit from FUSU was suggested primarily to be secondary to decreased fracture redislocation as functional end results after 6 months were excellent or good in 92% of the patients treated with FUSU and in those treated with DPI these were 86%. The functional results in poorly reduced fractures were not inferior in patients treated with FUSU then with DPI; FUSU probably did not cause any harm.

THOMAS et al (1985) presented the result of a prospective randomized trial of 100 Colles' fractures in which the Roehampton brace had been compared to a conventional plaster technique. This brace was a combination of modern thermoplastic materials with traditional chinese splintage techniques. The brace allowed total freedom of the hand and approximately 50% of normal wrist movements. The author concluded that in the treatment of Colles' fractures the Roehampton brace held the reduction more effectively than plaster and allowed better immediate function of the wrist. It was easy to apply, adjustable, reusable and was preferred by the patient.

COONEY, DOBYNS AND LINDSCHEID (1980) pointed out that soft tissue injury was partly responsible for the resulting stiffness. After early mobilization of an injury, the blood supply to bone and soft tissues returns rapidly to normal and joint stiffness is decreased. MULLER et al (1979), SALTER et al (1980). With these in mind DIAS et al 1987 studied the



value of early mobilization in the treatment of Colles' fractures. Early wrist movement hastened functional recovery and led to earlier resolution of wrist swelling. Discomfort was no greater than in patients who were treated conventionally. The bony disformity, which recurred irrespective of the method of treatment, was not adversely affected by early mobilization.

WAHLSTROM (1982) found that immobilization of the forearm in supination was less likely to maintain postreduction position.

Twenty patients with Colles' fractures were treated with a functional brace that allowed wrist movements. The result was compared with a similar group of patients treated with a plaster cast. Dorsal displacement of the fracture was less and wrist function was better in the brace group. Swelling of the hand in the early stages was observed in the brace group; and because this necessitated brace adjustment, increased medical supervision was necessary for this period (FERRIS et al, 1989).

A comparison of radiographical and functional results after displaced distal radius fractures in 41 patients treated by external fixation (EF), 36 patients treated by functional bracing in supination (FUSU) and 49 patients treated by dorsal plaster immobilization (DPI) was performed by SOLGAARD et al (1989). The radiographical results were significantly better after EF than after non-operative treatment. But functional result 3 & 6 months after demonstrated no significant difference between the three

series. Consequently EF and FUSU do not restore wrist function faster than conventional plaster treatment (DPI) but EF improves the radiographical result, though the rate of complication is higher.

BRUIJN (1987) compared functional bracing and conventional plaster treatment and found no significant difference in functional results after 3 months.

Two comparative studies of external fixation and plaster treatment have been published:

JENKINS (1987) and associates evaluated only radiographical results and found external fixation to be superior. The same was demonstrated by KONGSHOLM (1987). He also demonstrated superior functional results at one year after external fixation.

SANGWAN et al (1990) conducted a comparison between functional cast bracing in supination (FUSU) and conventional below-elbow plaster cast in pronation. In spite of no significant difference between the anatomical end results between the two groups the functional results were far superior in the castbracing group. Early motion in the cast brace did not jeopardise the maintenance of volar tilt. The brace did not show any significant role in preventing the collapse of the fragments.

A new prefabricated functional brace which consisted of two pieces of moulded polypropylene, a large dorso lateral and smaller antero ulnar portion connected by two elasticated velcro straps with graduated marks to allow a pre determined

tension to be applied was used by MOIR et al (1991) for the treatment of Colles' fractures. It exerts greater and more sustained loading over the fracture site than traditional plaster and thus is more likely to be effective in maintaining reduction. It allows mobility of the wrist which should result in early return of function.

The high levels of unsatisfactory results by way of different modalities of treatment of Colles' fractures, as can be made out from the discussed review of literature It holds good that there is ample scope for the betterment of the treatment modalities to achieve functionally improved results; with this thought in mind the present study was conducted.

# ***MATERIAL AND METHODS***

## MATERIAL AND METHODS

The proposed study of "Functional bracing in Colles' fracture" was conducted in the department of orthopedics M.L.B. medical college and associated hospital, Jhansi, through the concerned outpatient and casualty departments. A total of thirty cases of Colles' fracture presenting within one week of injury in the orthopedics department irrespective of the sex and age were included in the above mentioned study.

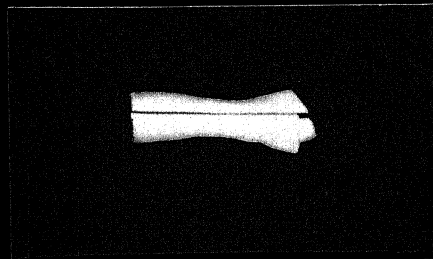
## MANAGEMENT OF FRACTURE

The patient on the day of presentation was given primary management in the form of manipulative reduction of fracture under suitable anaesthesia and application of a below elbow, Dorso-radial plaster of paris slab in pronation of forearm. The patient was also provided with primary treatment for the associated injuries if any. The data were collected and recorded as per proforma in Annexure I. The patient if not having associated injuries for which he/she needed admission was treated as an outdoor patient and was sent home, with the instructions to keep the involved upper limb elevated and to keep the fingers, the elbow and the shoulder of the involved limb actively moving. The patient was also instructed not to do supination of involved forearm. A pre reduction and a post reduction radiograph was taken in every case in which the reduction of the colles' fracture was done. This was done to confirm the injury, know its type and confirm the reduction. The patient was called back about a

## FABRICATION OF THE BRACE



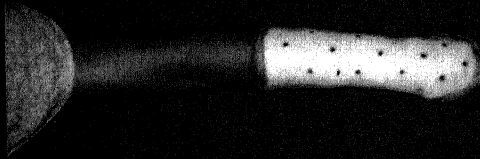
THE NEGATIVE MOULD : SLIT POSTERIORLY,  
READY TO BE TAKEN OFF THE LIMB



THE NEGATIVE MOULD : TAKEN OFF  
THE LIMB .



FINISHED PLASTER OF PARIS MOULD;  
READY FOR MOULDING POLYETHYLENE  
SLEEVE OVER IT. . .



THE POLYETHYLENE BRACE : APPLIED  
TO THE LIMB.



THE PALMAR FLEXION PERMITTED  
BY THE BRACE .

week later for review when the plaster of paris slab was tightened if required or was changed depending upon the amount of loosening of the first plaster slab. When the swelling had sufficiently subsided, around tenth day after reduction, fabrication of polyethelene brace was begun.

#### FABRICATION OF THE BRACE

The method of preparing the functional polyethelene brace comprises of following four stages:-

- A) IMPRESSION TAKING
- B) MAKING OF PLASTER OF PARIS MOULD
- C) MOULDING OF THE HIGH DENSITY POLYETHELENE SLEEVE
- D) FINAL TRIMMING AND FITMENT
- A) IMPRESSION TAKING (i.e. making the negative mould)

After the swelling around the involved wrist was sufficiently reduced; this was around the tenth day after of reduction, the impression taking was done. This involved forearm was shaved and directly over the skin (without cotton or cast padding) a thin plaster of paris cast was applied with its limits upto distal palmar crease and the first metacarpophalangeal joint distantly and just short of elbow joint proximally. This cast is carefully moulded over the distal forearm while the plaster is setting. keeping the wrist in neutral dorseflexion and forearm prone. This position was maintained till the plaster was completely set in about 5-10 minutes. This impression was taken off the limb by making a longitudinal slit over its dorsal aspect along whole of its length. For taking this impression readymade plaster of paris bandages were used.



ANNEXURE - I

The data were collected and recorded as follows:-

1. Case No:
2. Name of the patient:
3. Father's/Husband's name:
4. Age/sex:
5. Address:
6. Occupation of the patient:
7. Date of injury:
8. Mode of injury (along with brief history of injury):
9. Whether admitted - Yes/No
10. Side of Colles' fracture - Right/Left/Bilateral
11. Type of Fracture (according to FRYKMAN'S CLASSIFICATION)  
(As per Annexure - II)
12. Presence of dorsal comminution
13. Dorsal displacement and tilt: Present/Absent
14. Radial Displacement and tilt: Present/Absent
15. Impaction : Present/Absent
16. Date of reduction:
17. Anaesthesia used: local 2% xylocain/general/sedation
18. Position achieved after reduction:  
satisfactory/unsatisfactory
19. Associated injuries (if any):
20. Date of impression taking:
21. Date of Brace application:

ANNEXURE - II

- TYPE I : Extra-articular fractures without fracture of the distal ulna.
- TYPE II : Extra-articular fractures accompanied by fracture of the distal ulna.
- TYPE III : Intra-articular fractures involving the radio-carpal joint but without fracture of distal ulna.
- TYPE IV : Intra-articular fractures involving the radio-carpal joint and accompanied by fracture of distal ulna.
- TYPE V : Intra-articular fractures involving the distal radio-ulnar joints but without fracture of the distal ulna.
- TYPE VI : Intra-articular fractures involving the distal radio-ulnar joint and accompanied by fracture of the distal ulna.
- TYPE VII : Intra-articular fractures involving both the radio-carpal and the distal radio-ulnar joint but without fracture of the distal ulna.
- TYPE VIII : Intra-articular fractures involving both the radio carpal and the distal radio-ulnar joints and accompanied by fracture of the distal ulna.

The impression after removing it from the forearm was reconstructed by closing the slit made in it with the help of the plaster bandage. All the openings of the impression except for the proxymal one were sealed with the plaster of paris bandages preserving the exact shape of the impression. Thus the negative mould to cast the positive plaster of paris mould was prepared.

#### B) MAKING OF THE PLASTER OF PARIS MOULD

The negative plaster of paris mould was filled by pouring semisolid paste of plaster of paris through its only opening proximally. An iron rod was put inside the plaster of paris paste in the negative mould and was maintained there till the plaster was set. This rod was later used for handling the thus casted positive plaster of paris mould. The outer negative plaster mould was removed 10-15 minutes later. The positive mould was thus ready for moulding the high density polyethelene sleeve over it.

#### C) MOULDING OF THE HIGH DENSITY POLYETHELENE SLEEVE

The functional brace for the forearm was made using two millimetres thick high density polyethylene sheet. The sheet is cut according to the measurements of the positive plaster mould. This sleeve of polyethelene was heated in the oven upto 200 degrees centigrade for about 20 minutes and then was snugly draped and moulded over the positive plaster of paris mould keeping the opening of the moulded polyethelene anteriorly.

#### D) FINAL TRIMMING AND FITMENT OF THE BRACE

The final trimming of the brace and its fitment was done in the presence of the patient. The final markings over the brace for trimming were done after making the patient wear the untrimmed brace. The brace was made to extend about one and a half cms. short of the elbow proximally and distally on the lateral and medial sides upto the tips of the styloid processes of radius and ulna and upto the line joining them anteriorly. On the posterior aspect of hand the brace extended upto about a centimetre proximal to the metacarpophalangeal joints with this extent gradually merging with the lateral and medial extents on the respective sides.

A leather piece was pasted to the inner side of the overlapped margin of the anterior opening of the brace to prevent pinching of the skin while fastening the brace. Multiple holes were made on the margins of the anterior opening of the brace; though these holes laces could be passed to fasten the brace after applying it over the forearm and wrist.

Whole of the brace was lined by 3 mm thick foam sheet to make it comfortable. 6 mm wide holes were punched in the brace at multiple sites to make it quite airy.

The patients were made to wear this brace after the forearm was cleaned with the spirit and talcum powder was applied over the skin. The patients were advised to wear this brace all the time and were advised to keep their fingers actively moving as much as they could. These patients were

also advised to move actively their elbows and shoulder of the involved side. These patients after application of the brace were allowed to do light work like writing with their involved limb. The supination of the involved forearm was discouraged.

The functional polyethylene brace thus prepared was a washable one and was opened under treating person's supervision for hygienic purposes till three weeks were completed after reduction ; after which the patients if found reasonably intelligent were allowed to take off the brace by themselves for cleaning purpose once a week. At around six weeks the brace was discarded.

#### FOLLOW UP

Most of the patients who were not having any associated injuries which required admission to the hospital were treated on outdoor basis.

The patients were instructed in detail regarding the active mobilization of fingers, wrists, elbow and shoulders with the brace on. The use of the neck sling was discouraged. The patients were instructed not to remove the brace by themselves upto 3 weeks after reduction.

For the follow up examination the patients were called back at 3 weeks and 6 weeks of reduction and examined clinically and radiologically, with particular reference to state of Callus, range of movements of wrist and fingers and complications if any:-

Callus : radiologically

at 3 weeks - good/moderate/poor

Movements at wrist

wks 3

wks 6

Dorsiflexion

Palmarflexion

Ulnar deviation

Radial deviation

Supination

(Supination was tested only at 6 weeks)

Movements of the fingers

Complications (if any)

At six weeks after reduction the elevation of the result was done with the help of guidelines laid down by GARTLAND AND WERLEY (1951) are as follows:-

POINT SYSTEM USED TO EVALUATE END RESULTS OF HEALED COLLES' FRACTURES.

RESULT	POINTS
<u>RESIDUAL DEFORMITY</u>	
1. Prominent ulnar styloid	1
2. Residual Dorsal tilt	2
3. Radial deviation of hand	2 to 3
Point range	0 to 3

SUBJECTIVE EVALUATION

1. EXCELLENT - No pain, disability or limitation of motion.	0
2. GOOD Occasional pain, slight limitation of motion, no disability.	2
3. FAIR Occasional pain, slight limitation of motion, feeling of weakness in wrist, no particular disability if careful, activities slightly restricted.	4
4. POOR Pain, Limitation of motion, disability, activities more or less markedly restricted.	6

Point range

0 to 6

OBJECTIVE EVALUATION

1. Loss of dorsiflexion	5
2. Loss of ulnar deviation	3
3. Loss of supination	2
4. Loss of palmar flexion	1
5. Loss of radial deviation	1
6. Loss of circumduction	1
7. Pain in distal radio-ulnar joint	1

Point range

0 to 5

COMPLICATIONS

## Artiritic changes

Minimal	1
Minimal with pain	3
Moderate	2
Moderate with pain	4
Severe	3
Severe with pain	5
Nerve complication (Median N.)	1 to 3
Poor function of fingers	1 to 2
Point range	0 to 5.

---

END RESULT POINT RANGESPOINTS

Excellent	0 to 2
Good	3 to 8
Fair	9 to 20
Poor	21 and above

---

The objective evaluation is based upon the following ranges of motion as being the minimum for normal function: Dorsiflexion, 45 degrees; Plamar flexion, 30 degrees; radial deviation, 15 degrees; ulnar deviation 15 degrees; pronation, 50 degrees; and supination, 50 degrees.

These were also recorded:-

1. Date of discarding of brace:
2. Complications due to the brace itself:
3. Complications other than those mentioned in the table above.



# ***OBSERVATIONS***

### OBSERVATIONS

In present day study, a total of thirty cases of Colles' fracture were treated by closed reduction and initial below-elbow dorso radial plaster of paris slab followed by application of a functional polyethylene brace for the early mobilization of the hand and the wrist, in the department of orthopaedics M.L.B. medical college and associated hospital, Jhansi. The observations made during the study are as follows:-

#### 1. AGE DISTRIBUTION

Age wise break up of the total patients is shown in table number one. The ages of the patients studied varied from 22 years to 80 years. The maximum number of patients (36.67%) belonged to the age group ranging from 41 to 50 years, with the mean age being 49.93 years.

TABLE NUMBER I

Showing the age distribution of patients

Age Groups in years	No of cases	Percentage
21 - 30	5	16.67
31 - 40	3	10.00
41 - 50	11	36.67
51 - 60	6	20.00
61 - 70	2	6.66
71 - 80	3	10.00
Total	30	100.00

LEGEND TO THE MASTER CHART1. OCCUPATION

- a. H.W. - House wife
- b. St. - Student
- c. FAR - Farmer
- d. Cl. - Clerk
- e. B.D. - Bus driver
- f. S.W. - Sweeper
- g. T.EA - Teacher
- h. SK. - Shopkeeper
- i. RETD - Retired

2. MODE OF INJURY

- a. F.O.S.H - Fall on out stretched hand
- b. T.A. - Traffic accident
- c. S.W. - Caught in steering wheel

3. ANASTEHEsia USED

- a. L.X.I. - Local Xylocain infiltration
- b. [-] - No anesthesia used
- c. GEN. - General
- d. SED - Sedation

4. TYPE OF FRACTURE

- a. D.T. - Dorsal tilt
- b. D.D. - Dorsal displacement
- c. R.T. - Radial tilt
- d. R.D. - Radial displacement
- e. IMP - Impaction

f. Type I  
to  
Type VIII - Frykman Classification

g. Com - Comminution

5. DORSALCOMMINUTION

[+] - Present

[-] - Absent

6. ASSOCIATED INJURY

a. [1] - Fracture of both bones of left forearm.

b. [2] - Fracture of II and III metacarpals right side

c. [3] - Fracture of trochanteric region of femur

d. [4] - Comminuted fracture of lower one third of both  
bones of left arm.

e. [5] - Chest injury

f. Lt. - Left

g. Rt. - Right

h. [6] - Fracture mandible + Fracture of pelvis

7. POST REDUCTION X-RAY

a. S - Satisfactory

b. U - Unsatisfactory

c. NR - No reduction was attempted

d. N - X-Ray not available

8. TIME BETWEEN REDUCTION AND BRACE APPLICATION

a. LF - Lost to follow up

9. X-RAY AT 3 WEEKS

a. MC - Moderate Callus

b. PM - Position of fragments maintained

c. PC - Poor Callus

d. GC - Good Callus

- e. mDT - Mild Dorsal tilt is present
- f. MDT - Moderate Dorsal tilt
- g. RD - Radial displacement & tilt
- h. RT - Radial tilt

10. COMPLICATIONS DUE TO BRACE

- a. SR - Skin rashes with contact dermatitis like picture.

11. FINGER FUNCTION

- a. G - Good
- b. F - Fair
- c. P - Poor

12. RESULT

As per GARTLAND & WERLEY guidelines (1951).

## 2. SEX INCIDENCE

The number of male patients were at par with the number of female patients under present study, with their numbers being 15 in each group (Table Number 2).

TABLE NUMBER II

Showing sex incidence of the patients

Sex	No of cases	Percentage
Male	15	50.00
Female	15	50.00
Total	30	100.00

## 3. OCCUPATION OF THE PATIENTS

The patients studied belonged to 7 different professions (Table Number 3). The number of the house wives topped the list (46.67%).

TABLE NUMBER III

Showing occupation of the patients.

Occupation	No of cases	Percentage
Housewife	14	46.67
Farmer	7	23.33
Govt. Servant	4	13.33
Shopkeeper	2	6.67
Driver	1	3.33
Teacher	1	3.33
Student	1	3.33
Total	30	100.00

## 4. MODE OF INJURY

Three modes of injury were encountered during this study: Fall on outstretched hand (FOSH), Road side accident (RSA) and in the third mode the forearm was caught in the steering wheel when the patient, the driver was trying to turn the bus. The commonest mode of injury was observed to be FOSH (90% cases). (Pie dig. 1, Table number IV)

TABLE NUMBER IV

Showing mode of injury

Mode of Injury	No of Cases	Percentage
FOSH	27	90.00
RSA	2	6.67
Others	1	3.33
Total	30	100.00

## 5. SIDE OF INVOLVEMENT

The left side was more commonly involved than the right one (Table number V, Bar dig No. 2). One patient with bilateral Colles' fracture was also a part of the study.

TABLE NUMBER V

Showing side of involvement

Side involved	No of cases	Percentage
Right	11	36.67
Left	18	60.00
Bilateral	1	3.33
Total	30	100.00

6. TYPE OF FRACTURE (Frykman's Classification as per Annexure No. I)

The maximum number of wrists suffering from Colles' fracture (38.70%) belonged to type I fracture group of Frykman's classification (table number VI).

TABLE NUMBER VI

Showing types of fracture(Frykman's classification)

Type of fracture	No. of wrists	Percentage
Type I	12	38.70
Type II	5	16.12
Type III	4	12.90
Type IV	1	3.22
Type V	3	9.67
Type VI	2	6.45
Type VII	2	6.45
Type VIII	2	6.45
Total	31	100.00

7. PRESENCE OF DORSAL COMMINATION

The comminution of the dorsal cortex of the distal radius was found present in 74.19% cases (table No.7).

TABLE NUMBER VII

Showing percentage of Dorsal comminution

Dorsal Comminution	No of wrists	Percentage
Present	23	74.19
Absent	8	25.80
Total	31	100.00



## 8. ASSOCIATED INJURIES

Out of 30 patients 23 had no associated injuries. Only 23.33% patients had some other injuries in association with the Colles' fractures (Table Number VIII, Bar dig 3). The distribution of these injuries among those 23.33% patients is shown in table number IX (Pie dig No.2 ) The highest incidence of associated injuries was of the fracture of the trochanteric region of femur (43.85%).

TABLE NUMBER VIII

Showing percentage of Associated injuries.

Associated injury	No of Cases	Percentage
Present	7	23.33
Absent	23	76.67
Total	30	100.00

TABLE NUMBER IX

Showing distribution of associated injuries among the patients with associated injuries.

Associated injury	No of cases	Percentage
Fracture of both bones of left forearm with fracture of II & III metacarpals.	1	14.28
Fracture of Trochanteric region.	3	42.85
Fracture mandible with fracture pelvis.	1	14.28
Chest injury	1	14.28
Comminuted fracture of both bones of forearm	1	14.28
Total	7	100.00

## 9. TYPE OF ANAESTHESIA.

The types of anaesthesia which were used for the reduction of Colles' fracture were infiltration of 2% Xylocain locally into the fracture site. In one case general anaesthesia was given after failure of reduction under the effect of local xylocain infiltration (table number 10). The local 2% xylocain infiltration was the commonest form of anaesthesia to be used in this series (73.33% cases).

TABLE NUMBER X

Showing type of anaesthesia used for reduction of Colles' fracture.

Type of anaesthesia	No of patients	Percentage
LXI	22	73.33
LXI + General	1	3.33
Sedation	2	6.67
None	5	16.67
Total	30	100.00

Note : LXI Local 2% Xylocain infiltration.

## 10. TIME LAPSED BETWEEN THE INJURY AND THE REDUCTION OF THE FRACTURE

No case presenting after 7 days of injury was included in the present study. The maximum number of cases presented between the 2nd and 5th day of the injury (36.67%), minimum within the first day. (table number XI)

TABLE NUMBER XI

Showing time lapsed between the injury and the reduction of the Colles' fracture.

Time interval (days)	No of cases	Percentage
Upto first day	9	30.00
II to V	11	36.67
VI to X	10	33.33
Total	30	100.00

#### 11. TIME LAG BETWEEN THE REDUCTION AND BRACE APPLICATION

The shortest period after which a brace could be applied after reduction in the present study was of 5 days. The longest period being of 17 days where the brace could not be applied earlier due to the presence of excessive swelling around the wrist. The brace could be applied between 11 and 15 days after reduction in maximum number of cases (72.41%) in the present study (Table number XII). One of the cases did not turn up for the brace application.

TABLE NUMBER XII

Showing Time lag between reduction and brace application.

Time interval (days)	No of cases	Percentage
0 to V	1	3.44
VI to X	4	13.79
XI to XV	21	72.41
XVI to XX	3	10.34
Total	29	100.00

Note: One patient did not turn up for the brace.

## 12. POSITION OF THE FRAGMENTS AT THREE WEEKS

The position of the distal fragment had not changed in relation to the postreduction position in 71.42% wrists whereas it had mildly displaced in 21.42% wrists and moderately so in 7.14% of cases (Table number XIII). In none of the cases rereduction at this stage was attempted. That way the brace was capable of maintaining the position of the fragments in 71.42% of wrists.

TABLE NUMBER XIII

Showing position of the fragments at three weeks

Position of fragments	No of wrists	Percentage
Position maintained	20	71.42
Mildly Displaced	6	21.42
Moderately Displaced	2	7.14
Total	28	100.00

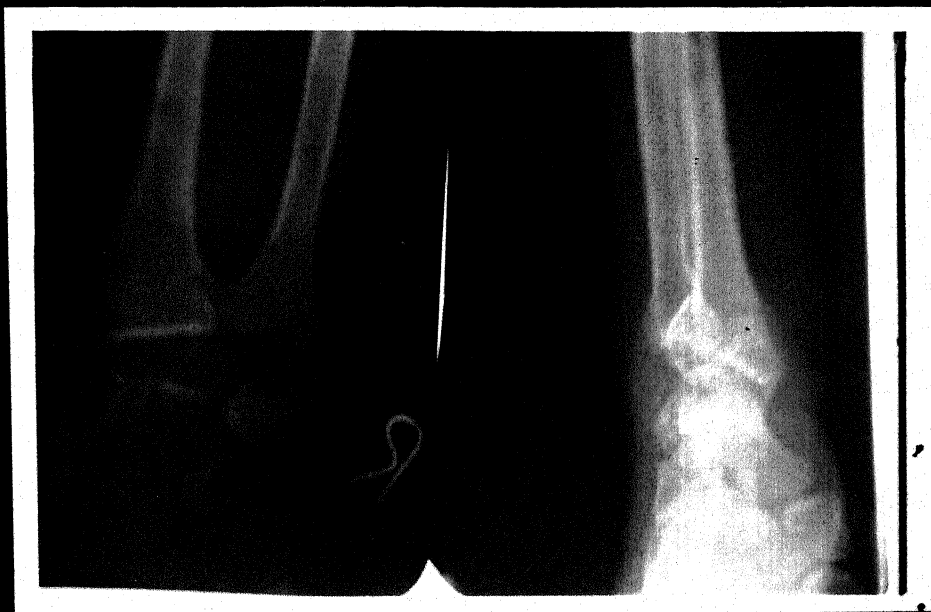
## 13. AVERAGE MOVEMENTS OF THE WRIST AT THREE WEEKS

The average of the degrees of movements of the wrists at three weeks have been shown in table number 14. The Dorsiflexion was the movement which was mainly restricted at this stage as the brace did not permit dorsiflexion.

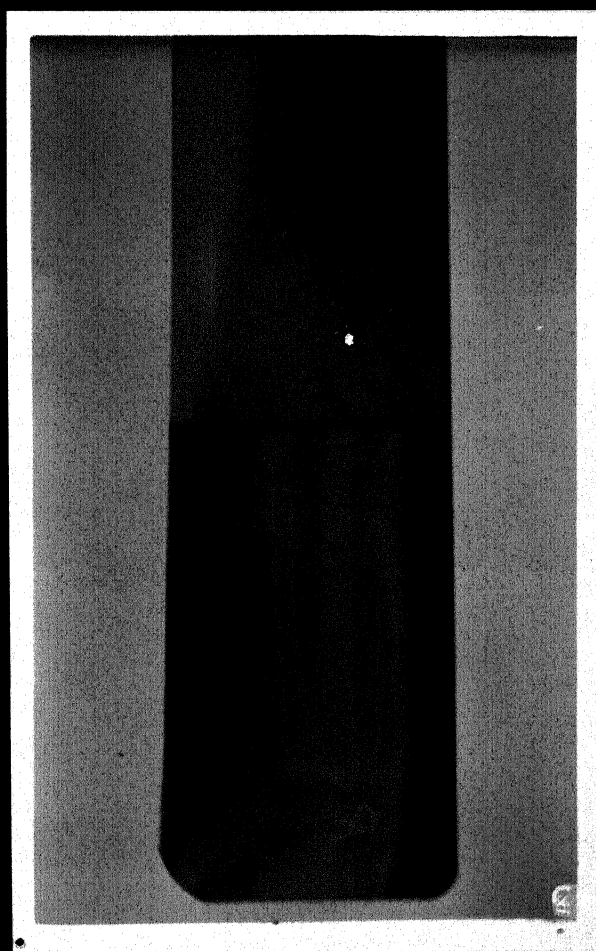
TABLE NUMBER XIV

Showing average movements of wrists at three weeks.

Movement's name	Average degrees of movement
Dorsiflexion	37.22
Palmarflexion	46.78
Radial Deviation	11.07
Ulnar deviation	16.23



PRE-REDUCTION X-RAY SHOWING A  
PIRKMAN'S TYPE - II FRACTURE.



POST-REDUCTION X-RAY OF THE ABOVE CASE WITH  
DORSO-RADIAL PLASTER OF PARIS SLAB ON, SHOWING  
THE REDUCTION ACHIEVED.



X-RAY SHOWING THE MAINTAINED  
REDUCTION IN PLASTER OF PARIS SLAB  
ONE WEEK AFTER REDUCTION.



THE POSITION OF FRAGMENTS IN  
BRACE THREE WEEKS AFTER  
REDUCTION.



X-RAY SHOWING THE MAINTAINED POSITION  
OF FRACTURE FRAGMENTS AT 6 WEEKS  
AFTER REDUCTION, WHEN THE  
BRACE WAS DISCARDED.

#### 14. PATIENTS COMPLETING THE STUDY

Out of thirty patients taken for this study one patient did not turn up for the brace application and two were lost to follow up after the brace application. In this way only 27 patients with 28 injured wrists (one patient had bilateral Colles' fracture) completed the study.

#### 15. FINGER FUNCTION AT SIX WEEKS

The finger function was given its due importance for assessing the functional results at six weeks. It was labelled GOOD in 85.71% hands and poor in only 3.75% (table number 15).

TABLE NUMBER XV

Showing finger function on the involved side at six weeks.

Function	No of hands	Percentage
Good	24	85.71
Fair	3	10.71
Poor	1	3.57
Total	28	100.00

#### 16. RESULTS ACHIEVED AT SIX WEEKS (as per guidelines laid by GARTLAND & WERLEY 1951).

The results achieved at six weeks were graded on the basis of above mentioned guidelines and in this way 25% patients had excellent and 42.85% patients had good results (table number XVI, Bar dig No. 4).



TABLE NUMBER XVI

Showing results achieved at six weeks.

Grading of results	No of wrists	Percentage
Excellent	7	25.00
Good	12	42.85
Fair	9	32.14
Poor	0	00.00
Total	28	100.00

#### 17. COMPLICATIONS DUE TO BRACE

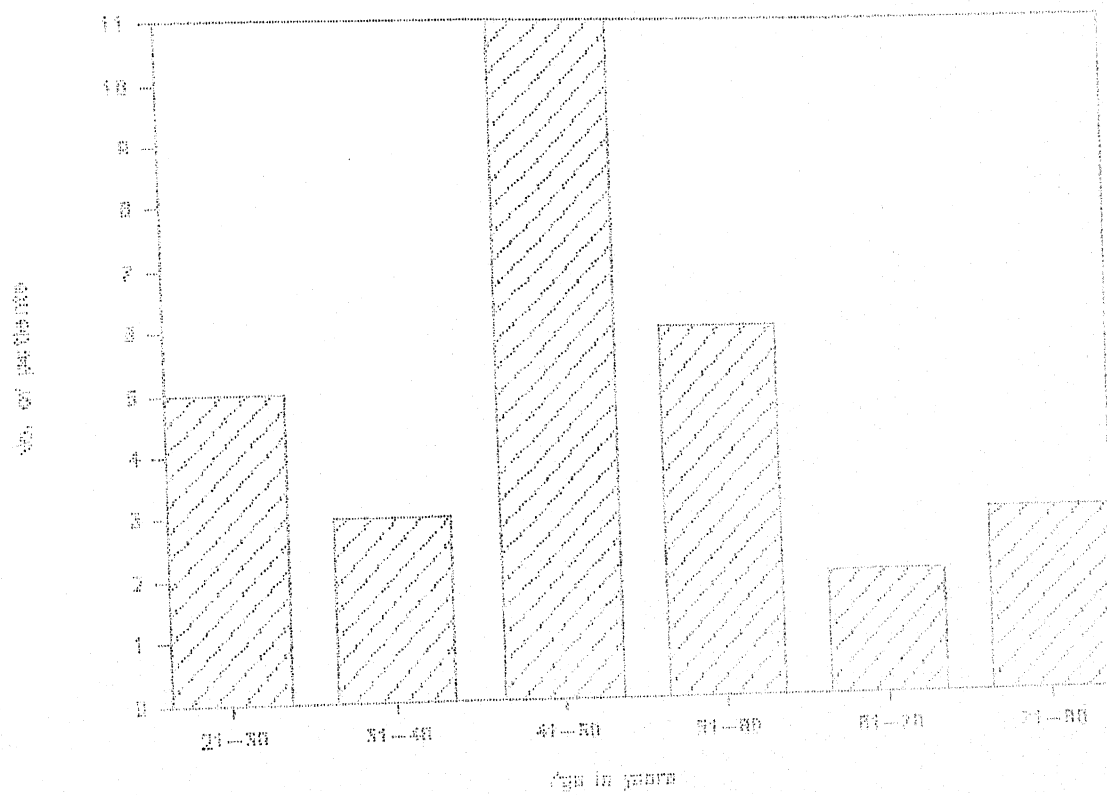
None of the patients undergoing the treatment with functional polyethylene brace met with any severe complications. Minor complications in the form of skin rashes under the brace were seen in six patients out of 27. These could be easily managed with the help of hygienic measures (table number XVII).

TABLE NUMBER XVII

Showing complications due to brace.

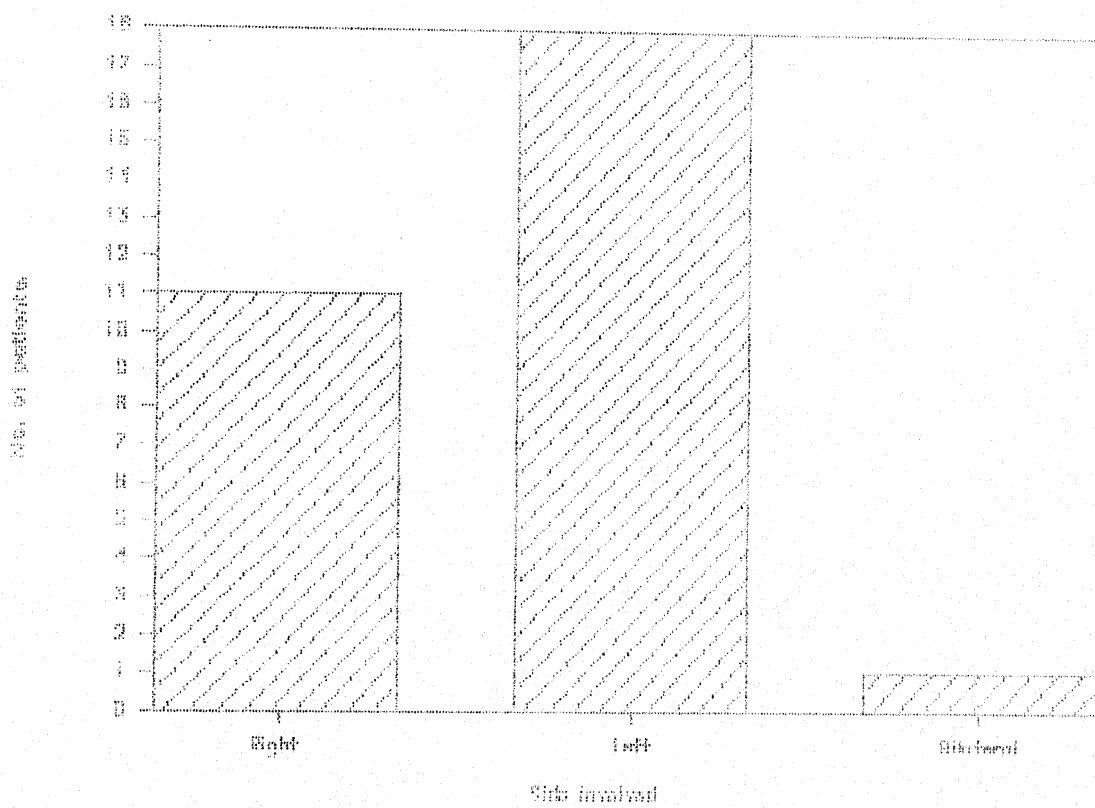
Complications	No of wrists	Percentage
Minor skin rashes	6	21.42
None	22	78.57
Total	28	100.00

Bar diagram showing age distribution.



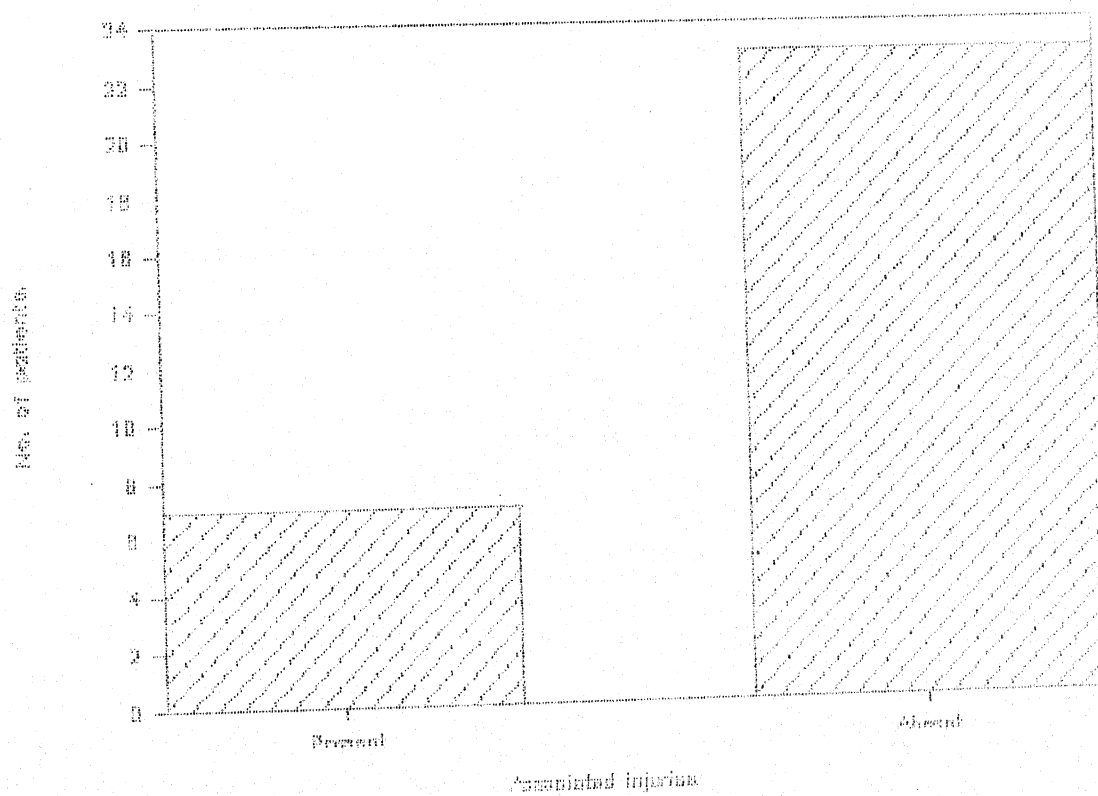
GRAPH - 1

Bar diagram showing side involved.



GRAPH - 2

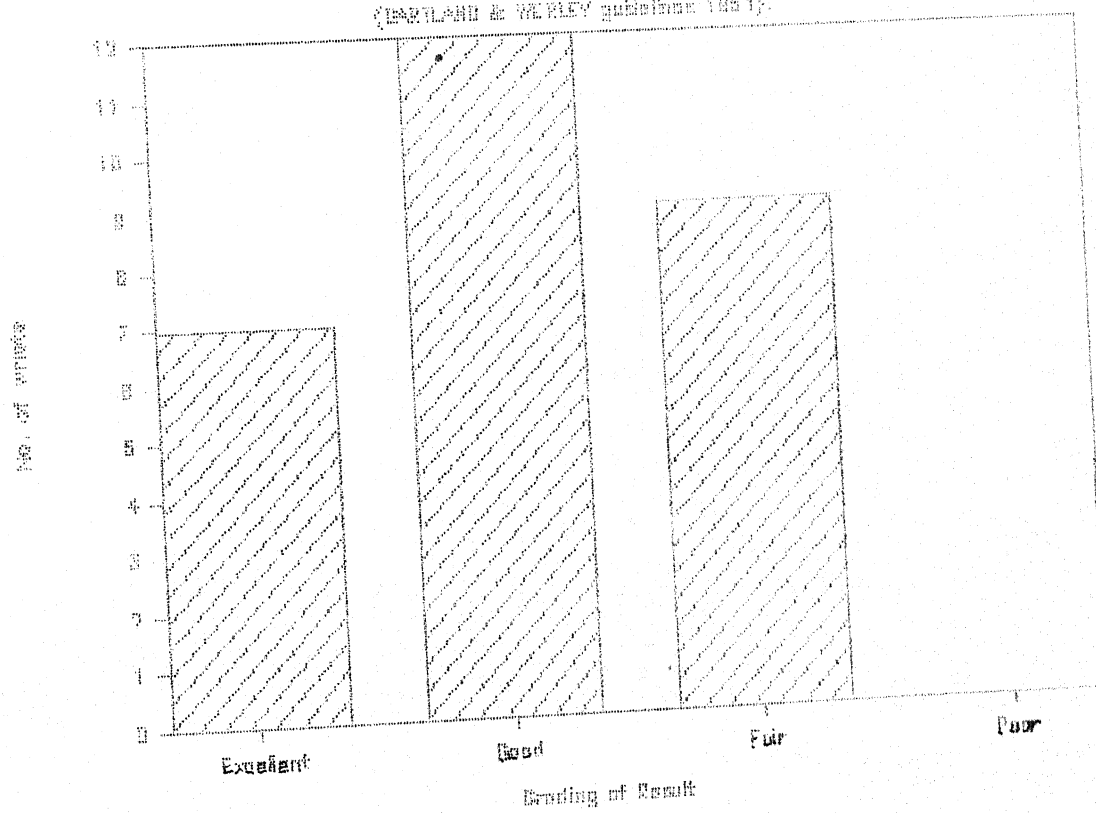
Distribution of associated injuries.



GRAPH - 3

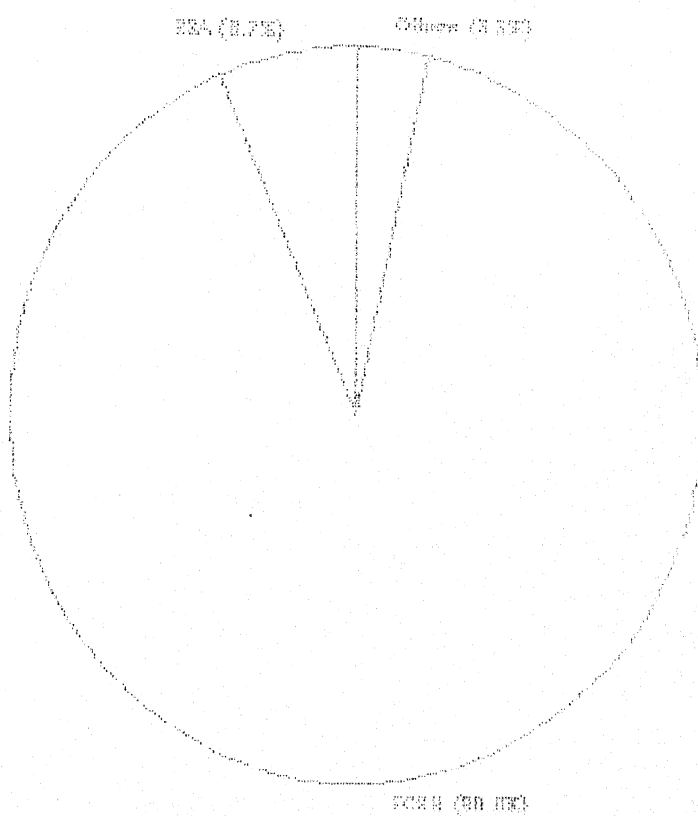
Results achieved at 6 weeks.

(DARTLAND & WELBY guidelines 1951).



GRAPH -4

Pie diagram showing mode of injury



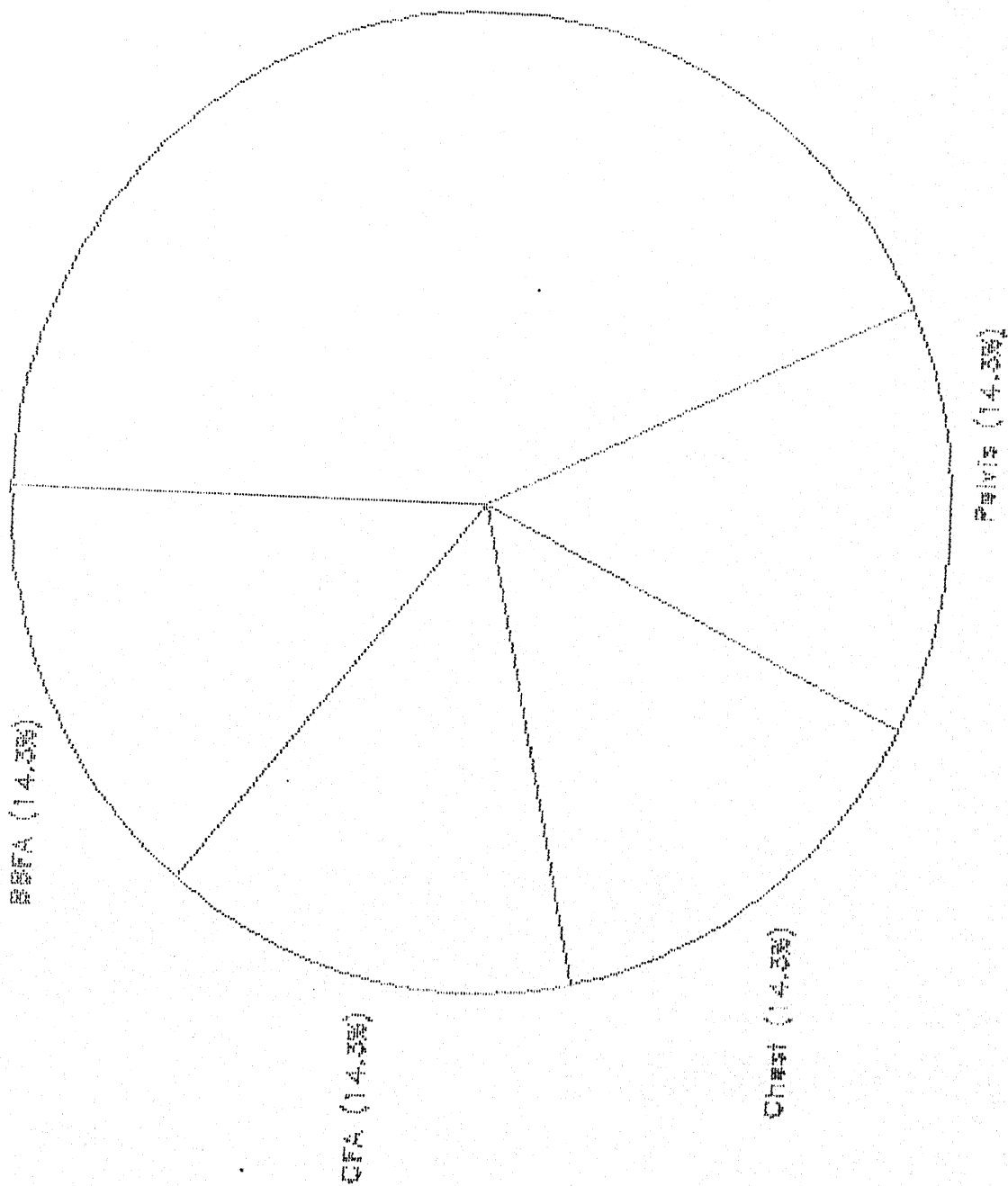
INDEX:

RSA: ROAD SIDE ACCIDENT

FOSH: FALL ON OUTSTRETCHED HAND

PIE DIAGRAM - 1

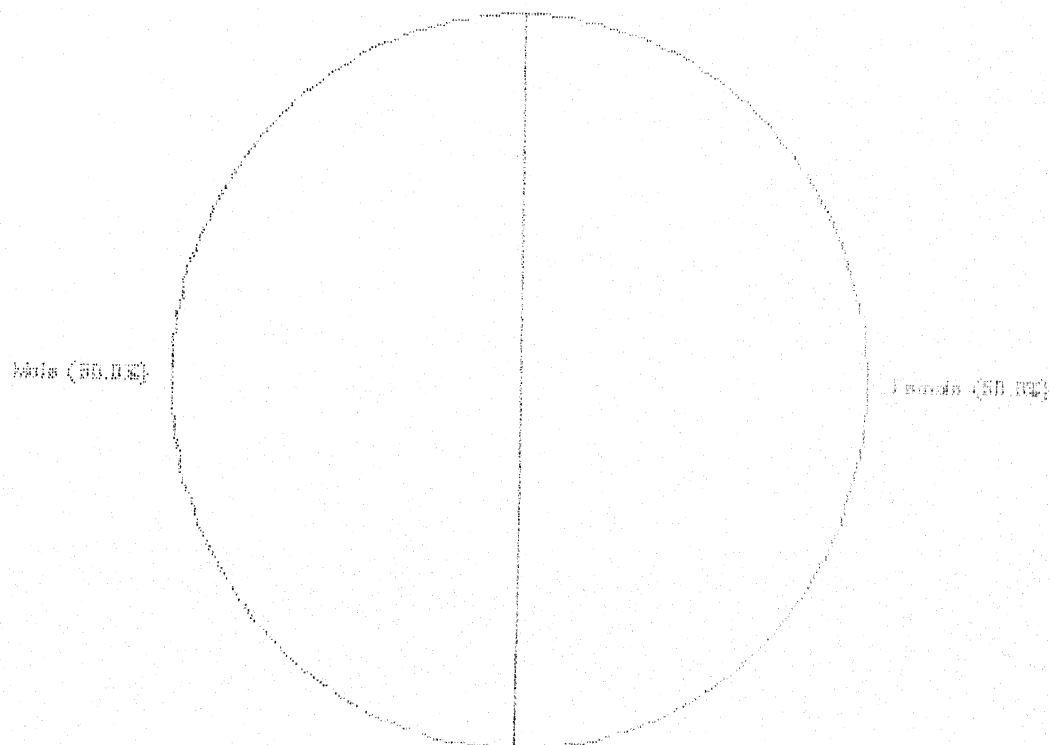
# Associated injuries in the patients with associated injuries.



## INDEX:

- BBFA - BOTH BONES LEFT FOREARM
- FRACTURE + II & III METACARPAL FR.
- CFA - COMMUNUTED FR. OF BOTH BONES OF LEFT FOREARM
- CHEST - CHEST INJURY
- PELVIS - PELVIS FR. + MANDIBLE FR.
- TRF - TROCHANTERIC FR.

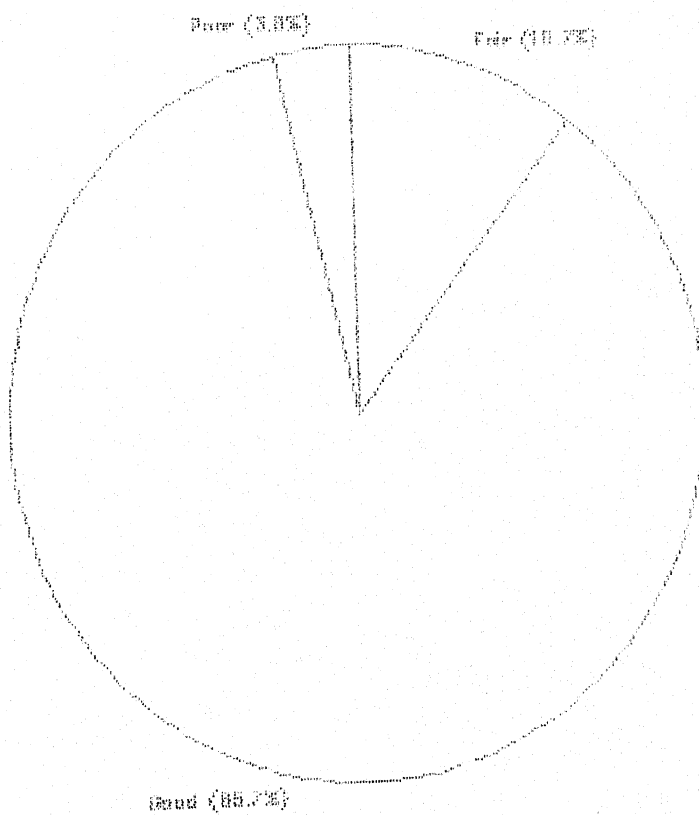
Pie diagram showing sex incidence.



PIE DIAGRAM -3



Finger function at six weeks



PIE DIAGRAM - 4

# ***DISCUSSION***

## DISCUSSION

The goal of fracture treatment is restoration of the function of the part involved along with restoration of the anatomy of that part. After the injury the function of the involved part is adversely affected and the aim of the treatment should be restoration of the normal function. With the conventional methods of treatment of fracture the stiffness of the joints incorporated in the plaster is the main impediment in gaining back the function of the injured part at the earliest, particularly so in elderly. To overcome this shortcoming of this conventional treatment method, the concept of functional bracing was introduced by SARMIENTO et al. recently. This has very much found its applicability to the colles' fractures. The functional brace treatment of colles' fracture combines the property of the plaster cast by holding the fracture fragments in position and the early mobilization of the wrist joint and the joints of the fingers of the involved side; the latter in turn makes the hand available for early return to work. Thus the economy of the patients is also taken care of. Early mobilization while a fracture is healing seems to provide an opportunity for rapid bone healing by allowing maintenance of joint movement and muscle action so that they are in a functional state at the completion of fracture treatment in a functional brace. The most desirable end result of an extremity fracture would be a limb capable of full function as soon as the fracture is healed.

The present study though small has tried to evaluate the use of functional polyethylene brace for the treatment of simple colles' fracture (27 cases with 28 wrists, as one was bilateral). In this series great emphasis has been on the early mobilization of the wrist, the fingers, the elbow and the shoulder of the involved side with the brace on to prevent the complications like difficult stiffness of fingers, wrist, shoulder hand syndrome, Sudeck's ostiodistrophy.

In the present study the ages of the patients ranged from 22 years to 80 years with the mean age in the fifth decade. This is in coherence with the studies conducted by Sarmiento (1975), Rosetzsky (1982), Stewart et al (1984). Stewart et al's study was in coherent with the present one in that the mean age in their study was 60.2 years. In the present study the number of patients decreased towards the higher and lower extents of the age. Probably the amount of osteoporosis is responsible for this pattern of age distribution and also the lesser number of individuals of the higher age groups available, contributed to present pattern of age distribution.

Most of the previously made studies show that there is a dominance of females among the sufferers of the colles' fracture. But the present study does not match with this. The equal number of male and female sufferers is probably insignificant as the sample for this study was very small. If it would have been a large one findings similar to those of other studies would have been a likely outcome.

Profession wise the house wives topped the list of the sufferers of the colles' fractures in the present study. The study made by Smaill (1965) also observed dominance of housewives among the sufferers of this fracture. The dominance of the house wives in the present study is probably an indirect indication of the dominance of females among the colles' fracture victims.

Considering the mode of injury in the present study we found that the colles' fracture by most of the patients was sustained as a result of a fall on outstretched hand (FOSH). The rest were sustained in road side accidents and a steering wheel accident. In the literature FOSH is one of the commonest mode of injury.

Out of thirty cases entered into the study the left side was more common to get a colles' fracture: 60% of the wrists involved were left ones. Bacorn and Kurtzke (1953), Smaill (1965), Ajay Gupta (1991) have all reported higher incidence of colles' fracture in the left wrist. Bacorn and Kurtzke could not affix a reason to this finding of theirs. In the present study one case of bi'ateral colles' fracture was also a part.

The fractures were classified according to Frykman's classification (1967) in the present study. According to this the maximum number of cases fell in type I (38.70%). In Frykman's study (1967) also the maximum number of cases were in type I. So this observation of ours matches with that made by Frykman.

The comminution of the dorsal cortex of the distal end

of the radius was not taken into account by Frykman in his classification. It was thought important to record the state of dorsal cortex in the pre reduction X-rays in this study. An attempt to correlate this with the recurrence of the deformity was made and it was found that the wrists in which there was a recurrence of the deformity were all having comminution of dorsal cortex. All the cases with dorsal comminution however did not show settling. It was only in 8 wrists out of 23 with dorsal comminution that the settling was observed in our study. A similar inference, that the original deformity usually recurs in the colles' fracture has been made by many authors. In Gartland and Werley series 81% of the fractures had a residual dorsal tilt. In Sarmiento's study (1975) of functional bracing in supination only 61% of the cases could be maintained in anatomical position, or with slight deformity. In the present study 65% of the cases could be maintained without a deformity. There was a mild displacement in 6 wrists out of 28. This way the results obtained in our series were much better than Gartland and Werley's, who treated the colles' fracture in conventional plaster. Our results were better than those of Sarmiento who treated the colles' fracture in functional brace in supination.

The average movements of the wrists at 3 weeks which were observed in this series were gained quite early, with the functional treatment in polyethylene brace. The dorsiflexion was 82.71%, Palmar flexion was 64.12%, Radial

deviation was 73.80% and Ulnar deviation was 108.20% of the minimum required range of movement considered by Gartland and Werley (1951). The pronation was full in all the cases as the forearm was kept in pronation most of the times.

The finger function which was observed at 6 weeks was good in 85.71% hands, fair in 10.71% hands and poor in only 3.57% i.e. only in one hand. Bacorn and Kurtzkey in a review of 2000 patients, reported restriction of finger motion in 48% cases and Sarmiento in his study (1975) on functional bracing in supination observed 12.12% cases with restricted finger movements, and this was at 6 months. Whereas in our study the finger movements observed were gained this much at 6 weeks.

The functional results were assessed at 6 weeks with the help of same criteria which were used by Gartland and Werley. We observed satisfactory results (excellent and good) in 67.85% wrists and fair results in 32.14% wrists. No poor functional results were observed. Gartland and Werley obtained 68.30% satisfactory results at a much later stage of follow up, so in our study we could obtain similar functional results with functional brace treatment much earlier than those obtained by conventional cast treatment of colles' fracture.

In our series the 8 cases who had residual deformity, all came out with four good and four fair functional results. This observation contradicts the view that a poor anatomical position of fragments is compatible only with a poor functional result. No major complications like difficult

stiffness of wrists, fingers, shoulder or elbow were observed in the present study. Neither were any other complications related to colles' fracture observed except for some minor skin rashes which were due to allergic reaction to the brace and could be easily managed.

Thus there was an additional benefit of getting the fingers and wrist mobilized early besides the maintenance of position of fragments in the functional polyethylene brace. The conventional plasters which required a frequent change as the swelling disappeared was also not a requirement of the brace, as this could be tightened to compensate for the diminishing swelling and thus was economical. Another benefit with the brace was that it could be removed from time to time for taking care of the skin of forearm and cleaning of the brace itself.

With the light work allowed with the functional polyethylene brace on the patient could return to his work earlier than when treated in the conventional cast.

All the fractures treated with functional brace united excellently by the end of 6 weeks when the brace was discarded. Thus the desirability of the gain of near normal functional state of the hand and wrist by the time the fracture healed was fulfilled.

Cosmetically the functional brace which was made up of polyethylene was more acceptable to the patients. The main attraction of the brace was that the proper hygiene could be maintained even during the treatment days which was not



possible with the plaster of paris cast and thus the problems like itching, superficial infection of the skin or its maceration were avoided altogether. The freedom of movement of the wrist and fingers without causing movement at the fracture and pain also made the functional brace the most desirable alternative to the conventional cast treatment.

# **CONCLUSION**

### CONCLUSION

The present study of functional bracing in Colles' fracture was conducted in the department of orthopaedics, M.L.B. Medical college and associated hospital, Jhansi. The result was evaluated and compared with the results of other worker's studies.

The functional polyethylene brace for the treatment of the Colles' fractures has got certain outstanding advantages over the plaster of paris casts which are conventionally used:

1. The functional polyethelene brace avoids the development of the usual complications of the Colles' fracture.
2. The functional polyethylene brace is economical in that it does not need a change which is usual with the plasters.
3. The early mobilization of the fingers, wrist, elbow and shoulder causes the early restoration of the function of the involved upper limb at the same time holding the fracture fragments in position.
4. It enhances the fracture union.
5. It produces good range of movements of the hand and wrist before the fracture is healed.
6. The functional polyethylene brace is very light in weight and is very comfortable to the patient. It is better cosmetically too.
7. It improves the socio-economic status of the patient by way of his return to work early.

It can be therefore concluded that the method of functional polyethylene bracing in the management of colles' fracture is a simple and effective method.

This amalgamates the advantage of the plaster of paris cast of holding the fracture fragments in position with the advantage of early mobilization made available by brace itself. The early mobilization is very much desirable as the elderly individuals, the usual sufferers of colles' fracture, tolerate immobilization very badly and develop difficult stiffness of fingers and wrist. Thus the functional polyethylene brace holds an upper hand in that it is light in weight, adjustable, washable, removable for hygiene, holds the fragments satisfactorily and allows early mobilization of the hand and wrist.

On the basis of the present study, the early recovery of normal function and union with satisfactory (excellent and good) functional results in majority of cases, indicates that it is a good and acceptable method to practice for the treatment of colles' fractures of simple nature.

This series is small and many more cases are required to be treated by the functional polyethylene brace before the results could be statistically evaluated, so, that this regimen is universally acceptable.

# ***BIBLIOGRAPHY***

## BIBLIOGRAPHY

1. ALFRAM, PER-AXEL AND BAUER, G.: Epidemiology of fractures of the forearm. A biomechanical investigation of bone strength. J.B.J.S, 44-A:105, 1962.
2. BACORN, R.W., KURTZKE, J.F.: Colles' fracture: A study of two thousand cases from the New York state workmen's compensation board. JBJS 34-A, 643-658, 1953.
3. BARTON, J.R.: Views and treatment of an important injury of the wrist. Med. Examiner 1:365, 1838.
4. BASSETT ROBERT L.: Displaced intraarticular fractures of the distal radius. Clinical Orthop. 214, Jan 1987 148-152.
5. BATE J.T.: Apparatus for use in reduction and fixation of fractures of distal radius. Clinical orthopaedics No. 63 March-April 1969 190-195.
6. BECK, C.: Colles' fracture and the Roentgen rays. Med. News 72:230, 1898.
7. BOHLER (1929): Treatment of fractures Ed.4, Baltimore, William Wood and Co.
8. BOHLER: Treatment des fractures, flammation, Paris, 1944.
9. BRUIJN, H.P. de(1987): Functional treatment of Colles' fracture. Acta Orthop Scand (suppl) 223.
10. BUNGER, C. SOLUND, K. and RASMUSSEN, P.: Early results after Colles' fracture: Functional bracing in supination Vs Dorsal plaster immobilization. Arch Orthop Trauma Surg (1984) 103: 251-256.
11. CALDWELL, J.A.: Device for making traction on fingers, J.A.M.A. 96:1226, 1931.
12. CAROTHERS, R.G. and BOYD, FOSTER J.: Thumb traction technique for reduction of Colles' fracture. Arch. Surg., 58:848,1949.
13. CAROTHERS, R.G. and BERNING, D.N.: Colles' fracture. Am.J.Surg., 80:626, 1950.
14. CASSEBAUN, WILLIAM H.: Colles' fractures, J.A.M.A. 143:963-965, 1950.
15. CASTAING, J: Revue de Chirurgie Orthopedique et Reparatrice de l'Appareil Moteur Tome, 50., No. 5.

16. CHARNLEY, J.: The closed treatment of common fractures (3rd edition), E. and S. Livingston, Edinburgh, 1961.
17. CHOW, Y.C., FANG, H.C., SHANG, T.Y.: The integration of modern and traditional chinese medicine in the treatment of fractures. IV. Treatment of Colles' fractures. Chin Med. J 1964; 83:425-429.
18. CLANCEY G.J.: Percutaneous Kirschner-wire fixation of Colles' fracture: a prospective study of thirty cases. JBJS 66-A, NO.7, Sept 1984, 1008-1014.
19. CLOCK, W.R., BROWN, F.W. and MACKEL, F.O.(1957): Colles' fracture. J.Am.Med.Ass., 50, 43.
20. COLE J.E., OBLETZ B.E.: Communitied fractures of the distal end of the radius treated by skeletal transfixation in plaster cast. An end result study of thirty three cases. JBJS 48-A, No. 5, July 1966 931-945
21. COLLES, A. (1814): On the fracture of the carpal extremity of the radius. Edinburgh medical and surgical journal 10. 182.
22. COONEY W.P., LINSCHIED R.L., DOBYNS J.H.: External pin fixation for unstable Colles' fractures. JBJS 61-A, No.6, Sept 1979, 840-845.
23. COONEY W.P., DOBYNS J.H., LINSCHIED R.L.: Complications of Colles' fractures. JBJS 62-A, nO.4, JUNE 1980, 613-619.
24. COTTON, F.: The Treatment of Colles' fracture. New England J.Med., 219:912, 1938.
25. COZEN, J.: Colles' fracture. A method of maintaining reduction. California Med., 75:362, 1951.
26. DE PALMA A.F.: Comminuted fractures of the distal end of the radius treated by Ulnar pinning. JBJS 34-A, No.3., July 1952, 651-662.
27. DESAULT, P.J.: Oeuvres chirurgicales ou expose de la doctrine et la pratique de P.J.Desault par Xav. Bichat. Paris. Mequignon, 1801.
28. DIAS, J.J., WRAY, C.C., JONES, J.M., GREGG, P.J.: The value of early mobilization in the treatment of Colles' fractures. JBJS. 69-B, No.3, May 1987, 463-467.
29. DOWLING J.J., SAWYER B. Comminuted colles' fractures: Evaluation of a method of treatment. JBJS 43-A, No.5, July 1961. 657-667.
30. ELLIS JAMES; SMITH'S AND COLLES' FRACTURES: A method of

- treatment. JBJS 47-B, No.4, Nov 1965, 724-727.
31. FALLON, M.: Abraham Colles' 1773-1843. Surgeons of Ireland, London, William Heinemann medical books ltd., 1972.
  32. FERRIS, BARRY. D., THOMAS, NEIL P., DEWAR, MICHAEL E., SIMPSON, DAVID A.: Brace treatment of Colles' fracture. Acta Orthop Scand 1989; 60(1): 63-65.
  33. FORD, L.T., Jun., and KEY, J.A. (1955): Present day management of Colles' fracture. Journal of the Iowa state medical society, 45, 324.
  34. FRYKMAN, G.: Fracture of the distal radius including sequel-shoulder-hand-finger syndrome, disturbance of the distal radio-ulnar joint and impairment of nerve function. A clinical and experimental study. Acta orthop. Scandinavica, supplement 108, 1967.
  35. GARTLAND, J.J., Jun., and WERLEY, C.W. (1951): Evaluation of healed colles' fractures. JBJS, 33-A, 895.
  36. GIBSON, A.G.F., and BANNISTER G.C.: Bracing or plaster for Colles' fractures. JBJS 65-B, 221, 1983.
  37. GOLDEN G.N. : Treatment and prognosis of Colles' fracture. The lancet, march 1963, 511-515.
  38. GOYRAND, G.: Memoirs sur les fractures de l'extremite inferieure de radius, qui simulent les luxations du poignet. Gazette de Medicine. 3:664, 1832.
  39. GOYRAND, G.: De la fracture per contrecoup de l'extremite inferieure du radius. Journal Hebdomadaire 1:161, 1836.
  40. GREEN D.P.: Pin and plaster treatment of comminuted fractures of the distal end of the radius. JBJS, 57-A, No.3, April 1975, 304-310.
  41. GUPTA, AJAY.: The treatment of colles' fracture immobilization with the wrist dorsiflexed. JBJS, 73-B, No.2, MARCH 1991, 312-315.
  42. GUPTA M.C., AGARWAL R.P., MOHINDRA Y. AND KUMAR ANIL: Functional cast bracing in the treatment of colles' fracture. IJO, Vol 15 No. 1 59-65 (1981).
  43. GUTTMAN, A.P. (1959): Treatment of Colles' fractures. J.Int. Coll. Surg. 31:341.
  44. HAMSA, W.R. (1962): Treatment of Colles fracture. Neb. St. Med.J., 47:573.



45. JENKINS NH. JONES DG. JOHNSON SR. MINTOWT - CZYZ WJ (1987): External fixation of colles' fractures an anatomical study. J.Bohe and joint surg. 69-b:207-211.
46. JONES, R.(1915): Injuries of joints, p.110. London: Henry Frowde and Hodder & Stoughton.
47. KAIN, THOMAS, MANDEL, R.J., SNEDDEN, HAL E., STEWART, W.G., ADAMS, DAVID J.: Comminuted distal radius fractures: Two methods of treatment. Clinical orthopaedics & related research number 128, Oct 1977, 369.
48. KANE, A.A.(1964): Colles frature West Med., 5:124.
49. KENNEY, W.E. (1960): Important details in the management of fractures of the distal radius. Conn. Med., 24:324.
50. KESWANI, N.N.: Ancient Hindu orthopaedic surgery. I.J.O. Vol 1, No. 1 (June 1967) 76-94.
51. KONGSHOLM J (1987): Colles' fractures a clinical experimental and anatomical study. Acta Univ upsal 74.
52. KRISTIENSEN AMUND & GJERSOE EINAR : Colles' fractures: Operative treatment, indications and results. Acta Orthop. Scandinav. 39,1, 33-46.
53. KUDELKA, P. (1963) : On the treatment of Colles' fracture. Med. J. Aust., 1:616.
54. LAMBIRINUDI, C.(1938): Injuries to the wrist. Guy's hospital Gazette, 52, 107.
55. LIDSTORM, A. (1959): Fractures of distal end of radius. Acta Orthopaedica Scandinavica Supplementum, 41.
56. LINDEN, W.VANDER, ERICSON,R.: Colles' fracture. How should its displacement be measured and how should it be immobilized. JBJS 63-A, No.8, Oct. 1981. 1285-1288.
57. MALGAIGNE, J.F.: A treatise on factures. Packard, J.H. (trans) Philadelphia, J.B. Lippincott, 1859.
58. MATHYSEN, A.(1854).: Du Bandage plastre et de son application dans le traitement des fractures. Leige: Grandmont-Donders (Translated by Helen Rang).
59. MAYER, J.H.: Colles' fracture. British J. Surg., 27:629, 1940.
60. McAULIFFE, T.B., HILLIAR, K.M., COATES, C.J., GRANGE, W.J.: Early mobilization of Colles' fracturs. A

- prospective trial. JBJS. 69-B, No.5, Nov 1987, 727-9.
61. McNUTT, J.C.(1956):Pitfalls in the management of Colles' fractures. Illinois Med. J. 109. 133.
  62. MILLER, W.E.(1960): Colles' fracture. Sth. Med. J., 53:1382.
  63. MITAL, M.A. AND PATEL, U.H.: Fractures and dislocations about the distal forearm wrist and hand. An. J. Surg. 124:660, 1972.
  64. MOIR, J.S., WYTCH, R., ASHCROFT, G.P., NEIL, G., ROSS, N., WARDLAW, D.: Intracast pressure measurements in Colles' fractures. Injury (1991) 22(6) 446-450.
  65. MOORE, J.R.(1958): J.Bone jt. Surg. 40A, 1435.
  66. MULLER, M.E., ALLGOWER, M., SCHNEIDER, R., WILLENEGER, H. Manual of internal fixation: Techniques recommended by the A.O. Group. 2nd ed. Berlin etc: Springer-Verlag, 1979.
  67. OLDER, T.M.; STABLER, E.V.; and CASSEBAUM, W.H.: Colles' Fracture: Evaluation and selection of therapy. J. Trauma, 5:469-476, 1965.
  68. PARISIEN, S., SETTLING IN COLLES' FRACTURE: A REVIEW OF LITERATURE. Bull. Hosp. Joint Dis. 34:117-125, 1973.
  69. PELTIER, L.F. Eponymic fractures: Abraham colles' and colles' fracture. Surgery 35:322 1954.
  70. PELTIER, L.F.: Eponymic Fractures: Guillaume Dupuytren and Dupuytren's fracture. Surgery 43: 868, 1958.
  71. PELTIER L.F.: Fractures of distal end of radius. An historical account. Clin. Orthop., 187, 18-22. 1984.
  72. PETIT, J.L.: L' Art de Guerir les Maladies des Os. Paris, L.d'Houry, 1705.
  73. POOL CRISTOPHER, COLLES' FRACTURE: A prospective study of treatment. JBJS 55-B, No. 3, Aug 1973, 540-4.
  74. POUTEAU, C.: Oeliveres Posthumes de M. Pouteau: Memories, contenant quelques reflexions sur quelques fractures de l'arantbras, sur les luxations incomplettes du poignet et sur le diastasis. Paris, Ph-D. Pierres, 1783.
  75. RAVITCH, M.: Dupuytren's invention of the Mikulicz enterotome with a note on eponyms. Prespect Biol. Med. 22:170, 1979.

76. ROCKWOOD, C.A. Jr., and GREEN D.P.: FRACTURES, Philadelphia, J.B. LIPPINCOTT, 1975.
77. ROCKWOOD, C.A. Jr., and GREEN, D.P.: FRACTURES IN ADULTS. Philadelphia, J.B. Lippincott, 1984.
78. ROSETZKY, ALLAN.: Colles' fractures treated by Plaster and Polyurethane braces: A controlled clinical study. J.Trauma 1982, Nov, 22(11):910-913.
79. ROSS RE., GOUREVITCH, D., & LAWTON, A.: A prrspective randomized trial of functional bracing in Colles fracture. JBJS, 66-B, 1984, 776-777.
80. RUBINOVICH, R.M., RENNIE, W.R., Colles' Fracture: a comparison of functional and radiologic end results: JBJS, 66-B, (1984), 295.
81. RUSH L.V., RUSH H.L., Evaluation of Medullary fixation of fractures by the longitudinal pin. American J.of Surg. Sept 1949, 324-333.
82. RUSH, LESLIE V.: Closed Medullary pinning of Colles' fracture. Clinical Orthop. 3, 152-162.
83. SANDHU H.S., SINGH M., BAJAJ A.S., SINGH S: Closed reduction and percutaneous Kirschner wire fixation in Colles' fracture. IJO, VOL 20, No.2, (1986), 197-203.
84. SALTER, R.B., SIMMONDS, D.F., MALCOLM, B.W., RUMBLE, E.J., MACMICHAEL, D., CLEMENTS, N.D.: The biological effect of continous passive motion on the healing of full thickness defects in articular cartilage: An experimental investigation in rabbit. JBJS(AM), 1980; 62-A; 1232-51.
85. SARMIENTO AUGUSTO,: The brachioadialis. As a deforming force in Colles' fractures. Clinical Orthop 38: 86-92.
86. SARMIENTO AUGUSTO: A functional below the knee cast for tibial fractures. J.B.J.S; 49-A; 855-875, July 1967.
87. SARMIENTO AUGUSTO: A functional below the knee brace for tibial fractures. J.B.J.S; 52-A; 295-311, March 1970.
88. SARMIENTO AUGUSTO: Functional bracing of tibial and femoral shaft fractures. Clin. Orthop., 82:2-13, 1972.
89. SARMIENTO A. GILBERT W PRATT, BARRY N.C. & SINCLAIR W.F., Colles' fracture: Functional bracing in supination. JBJS 57-A, 311-317 (1975).

90. SARMIENTO, A., ZAGORSKI, J.B., SINCLAIR, W.F.: Functional bracing of Colles' fractures: a prospective study of immobilization in supination Vs pronation. Clin. Orthop. 1980; (146): 175-83.
91. SHECK MAX : Long term follow up of treatment of comminuted fractures of the distal end of radius: Transfixation with Kirschner wires and cast. JBJS 44-A, No.2, March 1962 337-351.
92. SMAILL G.B., : Long term follow up colles' fracture. JBJS 47-B, n01, 80-85 (Feb 1965)
93. SOLGAARD, S., BUNGER, C. and SOLUND, K.: Displaced distal radius fractures, A comparative study of early results following external fixation, functional bracing in supination, or dorsal plaster immobilization. Arch orthop Trauma Surg (1989) 109: 34-38.
94. SORE, A. (1965): Treatment of Colles fracture. Med. Tms. (London), 93:1283.
95. STEIN, A.H. and KARTZ, S.F.: Stabilization of comminuted fractures of distal inch of the radius: Percutaneous pinning. Clinical Orthop. Nov. 108, 1975. 174-181.
96. STEWART, H.D., INNES, A.R., BURKE, F.D.: Functional cast bracing for Colles' fractures: A comparison between orthoplast cast bracing and conventional plaster cast. JBJS, 66-B, 286, 1984.
97. STEWART, H.D., INNES, A.R., BURKE, F.D.: Functional cast bracing for Colles' fractures: A comparison between cast bracing and conventional plaster casts. (JBJS 66-B No-5, 749-753 (Nov '84)).
98. STEWART, H.D., INNES, A.R., BURKE, F.D.: The hand complications of Colles' fractures. The journal of hand surg. Vol 10-B, No.1 Feb 1985.
99. THOMAS, N.P. FERRIS, B.D., SIMPSON, D., and DEWAR, M.: The Roehampton brace. JBJS 67-B (1985), 493.
100. VILLAR, R.N., MARSH, D., RUSHTON, N., GREATORIX, R.A.: Three years after Colles' fracture: a prospective review. JBJS 69-B, No. 4, August 1987. 635-638.
101. WAHLSTORM, O. (1982): Treatment of Colles' fracture. Acta Othop Scand. 53: 225-228.
102. WATSON-JONES, R.: Fractures and joint injury, Vol. II. 4B, 1955.
103. WHITE, A.W.M. (1940): Colles' fracture. Canadian Med. Assn. Jr. 43, 148.